

Florida Power Corporation Crystal River
Units 4 and 5. Technical Support
Documents. Volume I

(U.S.) Environmental Protection Agency
Atlanta, GA

Sep 80



U.S. Department of Commerce
National Technical Information Service

NTIS

BIBLIOGRAPHIC DATA
SHEET1. Report No.
EPA 904/9-80-048a

2.

3. Recipient's Accession No.
PBCO 225048

4. Title and Subtitle

Florida Power Corporation Crystal River Units 4
and 5 Technical Support Document Volume 15. Report Date
September 1980

6.

7. Author(s)

EIS Preparation Section, EIS Branch, Region IV

8. Performing Organization Rept.
No.

9. Performing Organization Name and Address

Environmental Protection Agency, Region IV
345 Courtland Street
Atlanta, GA 30365

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address

Same as box 9

13. Type of Report & Period
Covered
Draft EIS

14.

15. Supplementary Notes

16. Abstracts

Florida Power Corporation Proposes to construct and operate two 695 MW (Gross) capacity coal-fired electric generating plants at the existing Crystal River complex in northwest Citrus County, Florida. This EIS examines project alternatives, impacts and mitigative measures related to groundwater, air, surface water, ecological, and socioeconomic and cultural systems.

17. Key Words and Document Analysis. 17a. Descriptors

Volume 1
Technical Support Document
Crystal River
Citrus County
Coal-Fired electric generating plants

17b. Identifiers/Open-Ended Terms

17c. COSATI Field Group

18. Availability Statement

19. Security Class (This
Report)
UNCLASSIFIED

21. No. of Pages

20. Security Class (This
Page)
UNCLASSIFIED

22. Price

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30308

EPA 904/9-80-048a
July 1980



Environmental Impact Statement

Draft

Florida Power Corporation Crystal River Units 4 and 5

Technical Support Documents Volume I

REPRODUCED BY
**NATIONAL TECHNICAL
INFORMATION SERVICE**
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30308

EPA 904/9-80-048
July 1980



Environmental Impact Statement

Draft

**Florida Power Corporation
Crystal River Units 4 and 5**

**Technical Support Documents
Volume I**

TECHNICAL SUPPORT DOCUMENTS

TABLE OF CONTENTS

<u>Volume</u>	<u>Chapter</u>		<u>Page</u>
I	1.0	<u>PURPOSE OF PROPOSED FACILITY AND ASSOCIATED TRANSMISSION</u>	1-1
	1.1	SYSTEM DEMAND AND RELIABILITY	1-1
	1.2	SYSTEM CAPACITY	1-20
	1.3	RESERVE MARGINS	1-22
	1.4	OTHER OBJECTIVES	1-31
	1.5	CONSEQUENCES OF DELAY	1-32
	1.6	ADDENDUM TO CHAPTER 1	1-38
	2.0	<u>THE SITE</u>	2-1
	2.1	SITE LOCATION AND LAYOUT	2-1
	2.2	REGIONAL DEMOGRAPHY, LAND, AND WATER USE	2-4
	2.3	REGIONAL HISTORIC, SCENIC, CULTURAL, AND NATURAL LANDMARKS	2-14
	2.4	GEOLOGY	2-20
	2.5	HYDROLOGY	2-30
	2.6	CLIMATOLOGY AND DISPERSION METEOROLOGY	2-73
	2.7	ECOLOGY	2-93
	2.8	AMBIENT AIR	2-206
	2.9	OTHER ENVIRONMENTAL FEATURES	2-217
II	3.0	<u>THE PLANT</u>	3-1
	3.1	ARRANGEMENT AND EXTERNAL APPEARANCE	3-1
	3.2	FUEL	3-9
	3.3	PLANT WATER USE	3-25
	3.4	HEAT DISSIPATION SYSTEM	3-39
	3.5	CHEMICAL AND BIOCIDES WASTES	3-49
	3.6	SANITARY AND OTHER WASTE SYSTEMS	3-72
	3.7	AIR EMISSIONS	3-81
	3.8	DIRECTLY ASSOCIATED TRANSMISSION	3-95
	3.9	DIRECTLY ASSOCIATED FACILITIES	3-96
	3.10	ONSITE DRAINAGE AND EROSION CONTROL	3-102

TECHNICAL SUPPORT DOCUMENTS

TABLE OF CONTENTS
(CONTINUED, PAGE 2 OF 3)

<u>Volume</u>	<u>Chapter</u>		<u>Page</u>
II	4.0	<u>SITE PREPARATION AND PLANT AND ASSOCIATED FACILITIES CONSTRUCTION/RESULTING ENVIRONMENTAL EFFECTS</u>	4-1
	4.1	SITE PREPARATION AND PLANT CONSTRUCTION	4-1
	4.2	UNAVOIDABLE ENVIRONMENTAL IMPACT	4-14
	4.3	IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES	4-21
	5.0	<u>ENVIRONMENTAL IMPACTS OF PLANT OPERATION AND ASSOCIATED TRANSMISSION FACILITIES</u>	5-1
	5.1	HEAT DISSIPATION SYSTEM	5-1
	5.2	IMPACTS ON SURFACE WATERS	5-24
	5.3	IMPACTS ON GROUNDWATER SYSTEMS	5-39
	5.4	PSD ANALYSIS--AIR QUALITY	5-71
	5.5	DIRECTLY ASSOCIATED TRANSMISSION SYSTEM	5-84
	5.6	DIRECTLY ASSOCIATED FACILITIES	5-85
	5.7	RESOURCES COMMITTED AND UNAVOIDABLE ENVIRONMENTAL IMPACTS	5-92
	5.8	MITIGATIVE MEASURES	5-95
	6.0	<u>ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS</u>	6-1
	6.1	BASELINE MONITORING AND RELATED INFORMATION	6-1
	6.2	PLANT CONSTRUCTION AND OPERATION MONITORING	6-37
	7.0	<u>ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION</u>	7-1
	7.1	INTRODUCTION	7-1
	7.2	COSTS AND BENEFITS OF THE PROJECT TO POWER USERS AND TO FLORIDA POWER CORPORATION	7-3
	7.3	EXTERNAL SOCIAL AND ECONOMIC COSTS	7-24

TECHNICAL SUPPORT DOCUMENTS

TABLE OF CONTENTS
(CONTINUED, PAGE 3 OF 3)

<u>Volume</u>	<u>Chapter</u>	<u>Page</u>
III	8.0 <u>ALTERNATE ENERGY SOURCES AND SITES</u>	8-1
	8.1 MANAGEMENT ALTERNATIVES	8-1
	8.2 ALTERNATIVE ENERGY SOURCES	8-11
	8.3 ASSESSMENT OF ALTERNATIVE SITES	8-18
	9.0 <u>PLANT DESIGN ALTERNATIVES</u>	9-1
	9.1 INTRODUCTION	9-1
	9.2 PLANT SITING, LOCATION, AND LAYOUT ALTERNATIVES	9-14
	9.3 COAL HANDLING SYSTEMS	9-42
	9.4 WATER SOURCE AND INTAKE ALTERNATIVES	9-55
	9.5 COOLING SYSTEM ALTERNATIVES	9-99
	9.6 ATMOSPHERIC POLLUTION CONTROL SYSTEM ALTERNATIVES	9-164
	9.7 WASTEWATER DISCHARGE SYSTEM ALTERNATIVES	9-200
	9.8 SOLID WASTE DISPOSAL SYSTEM ALTERNATIVES	9-233
	9.9 TRANSMISSION FACILITIES ALTERNATIVES	9-246

CHAPTER 1
TABLE OF CONTENTS

	<u>Page</u>
1.0 <u>PURPOSE OF PROPOSED FACILITY AND ASSOCIATED TRANSMISSION</u>	1-1
1.1 SYSTEM DEMAND AND RELIABILITY	1-1
1.1.1 Load Analysis	1-1
1.1.2 Demand Projections	1-9
1.1.3 Power Exchange	1-19
1.2 SYSTEM CAPACITY	1-20
1.3 RESERVE MARGINS	1-22
1.4 OTHER OBJECTIVES	1-31
1.5 CONSEQUENCES OF DELAY	1-32
1.6 ADDENDUM TO CHAPTER 1	1-38
1.6.1 General Comments	1-38
1.6.2 System Capacity	1-39
1.6.3 Reserve Margins	1-39
1.6.4 Other Objectives	1-41
1.6.5 Consequences of Delay	1-41

CHAPTER 1
LIST OF TABLES

<u>Table</u>	<u>Page</u>
1.1-1 History of Energy Use	1-2
1.1-2 Forecast of Energy Use	1-4
1.1-3 History and Forecast of Seasonal Demands	1-6
1.1-4 Florida Power Corporation Customer Growth Rates and Sales Growth Rates	1-15
1.1-5 Demand Growth Rates	1-16
1.1-6 Comparison of Forecast and Actual Peak Demands 1971-1973	1-17
1.1-7 Comparison of Forecast and Actual Peak Demands 1974-1976	1-18
1.3-1 Florida Power Corporation General Expansion Plan	1-23
1.3-2 Capacity, Demands, and Reserves for Peninsular Florida and Florida Power Corporation (With Crystal River Units 4 and 5 Included)	1-24
1.3-3 Capacity, Demands, and Reserves for Peninsular Florida and Florida Power Corporation (With Crystal River Unit 4 Omitted and Crystal River Unit 5 Included)	1-25
1.3-4 Capacity, Demands, and Reserves for Peninsular Florida and Florida Power Corporation (With Crystal River Units 4 and 5 Omitted)	1-26

CHAPTER 1
LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1.1-1	Annual Load Duration Curve	1-7
1.1-2	Historical and Predicted Peak Demands and Available Generation Capacity of Florida Power Corporation 1958-1988	1-8
1.3-1	Peninsular Florida Percent Reserves	1-27
1.3-2	Florida Power Corporation Percent Reserves	1-28
1.3-3	Florida Power Corporation Loss of Load Probability	1-29
1.5-1	Florida Power Corporation Loss of Load Probability	1-34
1.5-2	Florida Power Corporation Loss of Load Probability	1-36

1.0 PURPOSE OF PROPOSED FACILITY AND
ASSOCIATED TRANSMISSION
1.1 SYSTEM DEMAND AND RELIABILITY

1.1.1 LOAD ANALYSIS

Florida Power Corporation's history and forecast of energy use by customer class is shown in Tables 1.1-1 and 1.1-2, and the history and forecast of net seasonal peak demands is shown in Table 1.1-3. The forecasts shown have been adjusted to account for partial ownership of Crystal River Unit 3 both by Seminole Electric Cooperative, Inc., and by some of the municipal systems currently served by Florida Power. There is also an adjustment to account for the announced plans of Seminole Electric to build two 600 Mw coal units in the mid-1980's. Methods used in making these adjustments are discussed in detail in Section 1.1.2.

Figure 1.1-1 shows a per-unit annual load duration curve* that is expected to be typical of the Florida Power system for future years. Some small variations are expected in this curve from year to year, but these variations will not be particularly significant.

Figure 1.1-2 shows historical and predicted annual peak demands as well as the historical and projected generating capacity of Florida Power.

* Annual Load Duration Curve--A curve on a chart showing percentage of power supplied plotted against percentage of time of occurrence and illustrating the varying magnitude of the load during the period covered.

Table 1.1-1 History of Energy Use

Year	Rural & Residential					Commercial		Industrial		
	Gwh	Average No. of Customers	Average Kwh Consumption Per Customer	FPC % Increase*	Nat'l Avg Kwh Consumption Per Customer	National % Increase*	Gwh	Average No. of Customers	Gwh	Average No. of Customers
1958	844	211,421	3,991	15.0	3,351	6.0	431	28,746	592	817
1959	953	230,289	4,137	3.7	3,575	6.7	504	30,237	719	881
1960	1,115	248,533	4,488	8.5	3,818	6.8	562	31,754	828	936
1961	1,213	257,901	4,704	4.8	3,976	4.1	617	33,072	780	976
1962	1,386	269,131	5,150	9.5	4,220	6.1	720	34,152	907	762
1963	1,543	278,238	5,546	7.7	4,389	4.0	814	34,857	999	720
1964	1,714	288,498	5,942	7.1	4,653	6.0	918	35,836	1,049	860
1965	1,803	299,961	6,011	1.2	4,878	4.8	1,020	36,951	1,191	936
1966	2,066	313,205	6,597	9.7	5,211	6.8	1,136	38,228	1,353	1,007
1967	2,213	328,350	6,739	2.2	5,522	6.0	1,250	39,064	1,581	1,061
1968	2,671	347,466	7,688	14.1	5,985	8.4	1,426	40,953	1,732	1,131
1969	3,196	368,804	8,666	12.7	6,516	8.9	1,628	43,089	1,891	1,209
1970	3,696	392,593	9,415	8.6	6,995	7.4	1,844	45,033	1,912	1,248
1971	4,133	421,165	9,814	4.2	7,297	4.3	2,134	49,072	2,030	1,313
1972	4,717	459,002	10,277	4.7	7,598	4.1	2,403	53,606	2,197	1,384
1973	4,793	505,546	11,459	11.5	7,981	5.0	2,836	58,455	2,350	1,456
1974	5,286	541,702	9,758	-14.8	7,822	-2.0	2,935	60,478	2,422	1,486
1975	5,412	557,893	9,701	-0.6	8,077	3.3	3,188	60,598	2,479	1,466
1976	5,751	579,044	9,932	2.4	8,267	2.4	3,258	62,277	2,690	1,489
1977	6,374	601,062	10,604	6.8	8,693	5.2	3,527	64,783	2,813	1,655
1978	6,839	627,694	10,895	2.7	8,849	1.8	3,766	68,028	2,942	1,795
1979	6,927	660,010	10,496	-3.8	N/A	N/A	3,646	70,100	3,216	1,995

* Percent (%) increase of average KWH consumption per customer.

Table 1.1-1 History of Energy Use (Continued, page 2 of 2)

Year	Street and Highway Lighting Gwh	Other Sales to Ultimate Consumers Gwh	Total Sales to Ultimate Consumers Gwh	Sales for Resale Gwh	Utility Use, Losses, Billing Lag Gwh	Net Energy for Load Gwh
1958	7	103	1,977	353	302	2,632
1959	9	115	2,300	389	304	2,993
1960	11	116	2,632	327	341	3,300
1961	13	131	2,754	377	329	3,460
1962	13	145	3,171	435	385	3,991
1963	14	153	3,523	478	402	4,403
1964	17	167	3,865	540	386	4,791
1965	21	186	4,221	598	406	5,225
1966	17	207	4,779	691	452	5,922
1967	49	205	5,298	783	491	6,572
1968	56	226	6,111	925	591	7,627
1969	60	244	7,019	1,068	626	8,713
1970	64	261	7,777	1,252	826	9,855
1971	68	286	8,651	1,432	878	10,961
1972	72	305	9,694	1,828	1,156	12,678
1973	77	326	11,382	2,191	1,244	14,817
1974	83	292	11,018	2,296	1,088	14,402
1975	86	290	11,455	2,489	1,293	15,237
1976	93	337	12,169	2,648	1,215	16,032
1977	96	371	13,181	2,757	1,199	17,134
1978	99	404	14,050	2,997	1,086	18,133
1979	101	634	14,524	3,045	1,243	18,882

Source: Florida Power Corporation, 1978.

Table 1.1-2 Forecast of Energy Use

Year	Rural & Residential					Commercial		Industrial		
	Gwh	Average No. of Customers	Average Consumption Per Customer	FPC % Increase*	Nat'l Avg Kwh Consumption Per Customer	National % Increase*	Gwh	Average No. of Customers	Gwh	Average No. of Customers
1980	7,473	671,556	11,128	2.3			4,416	68,388	3,317	1,800
1981	7,904	692,844	11,408	2.5			4,703	69,888	3,516	1,872
1982	8,330	713,424	11,676	2.3			5,003	71,364	3,722	1,944
1983	8,736	734,100	11,900	1.9			5,242	72,800	3,939	2,000
1984	9,136	755,000	12,101	1.7			5,465	74,300	4,164	2,050
1985	9,531	774,900	12,300	1.6			5,666	75,800	4,401	2,100
1986	9,935	794,800	12,500	1.6			5,856	77,300	4,639	2,150
1987	10,298	814,100	12,650	1.2			6,036	78,800	4,871	2,200
1988	10,661	832,900	12,800	1.2			6,207	80,300	5,100	2,250
1989	10,979	851,100	12,900	0.8			6,364	81,700	5,319	2,300
1990	11,280	867,700	13,000	0.8			6,523	83,100	5,505	2,350
1991	11,549	881,600	13,100	0.8			6,676	84,400	5,670	2,400
1992	11,818	895,300	13,200	0.8			6,813	85,700	5,811	2,450
1993	12,086	908,700	13,300	0.8			6,943	86,900	5,945	2,500
1994	12,354	921,900	13,400	0.8			7,070	88,100	6,070	2,550
1995	12,627	935,300	13,500	0.7			7,198	89,300	6,191	2,600
1996	12,856	948,800	13,550	0.4			7,330	90,600	6,315	2,650
1997	13,066	962,500	13,575	0.2			7,453	91,900	6,441	2,700

* Percent (%) increase of average KWH consumption per customer

Table 1.1-2 Forecast of Energy Use (continued, page 2 of 2)

Year	Street and Highway Lighting Gwh	Other Sales to Ultimate Consumers Gwh	Total Sales to Ultimate Consumers Gwh	Sales for Resale Gwh	Utility Use, Losses, Billing Lag Gwh	Net Energy for Load Gwh
1980	117	513	15,836	3,561	1,693	21,090
1981	124	560	16,807	3,810	1,794	22,411
1982	132	605	17,792	4,057	1,892	23,741
1983	141	648	18,706	3,288	1,811	23,805
1984	150	687	19,602	2,810	1,935	24,347
1985	161	721	20,480	2,398	1,924	24,802
1986	172	750	21,352	2,004	2,000	25,356
1987	180	777	22,162	2,087	2,071	26,320
1988	188	800	22,956	2,165	2,140	27,261
1989	196	822	23,680	2,237	2,201	28,118
1990	204	841	24,353	2,302	2,257	28,912
1991	211	859	24,965	2,360	2,308	29,633
1992	217	876	25,535	2,414	2,359	30,308
1993	224	894	26,092	2,467	2,407	30,066
1994	230	912	26,636	2,519	2,454	31,609
1995	236	930	27,182	2,570	2,500	32,252
1996	242	948	27,691	2,616	2,545	32,852
1997	247	967	28,174	2,655	2,589	33,418

Source: Florida Power Corporation, 1978.

Table 1.1-3 History and Forecast of Seasonal Demands

Year	Summer Peak Demand Net Mw	Year	Winter Peak Demand Net Mw
1958	454*	1958-59	601*
1959	538*	1959-60	662*
1960	580*	1960-61	756*
1961	616*	1961-62	805*
1962	727*	1962-63	960*
1963	822*	1963-64	1,034*
1964	912*	1964-65	1,003*
1965	971*	1965-66	1,242*
1966	1,104*	1966-67	1,220*
1967	1,254*	1967-68	1,388*
1968	1,487*	1968-69	1,551*
1969	1,710*	1969-70	1,979*
1970	1,988*	1970-71	2,152*
1971	2,143*	1971-72	2,114*
1972	2,564*	1972-73	2,671
1973	2,862	1973-74	2,989
1974	2,835	1974-75	3,010
1975	2,975	1975-76	3,530
1976	3,223	1976-77	3,899
1977	3,407	1977-78	4,135
1978	3,521	1978-79	4,224
1979	3,667	1979-80	4,419
1980	4,190	1980-81	5,050
1981	4,440	1981-82	5,360
1982	4,710	1982-83	5,660
1983	4,750	1983-84	5,760
1984	4,950	1984-85	6,050
1985	5,030	1985-86	6,140
1986	5,160	1986-87	6,310
1987	5,380	1987-88	6,580
1988	5,500	1988-89	6,730
1989	5,590	1989-90	6,860
1990	5,770	1990-91	7,080
1991	5,740	1991-92	7,090
1992	5,900	1992-93	7,290
1993	5,850	1993-94	7,290
1994	6,010	1994-95	7,490
1995	6,060	1995-96	7,580
1996	6,200	1996-97	7,770
1997	6,340	1997-98	7,930

*Gross Mw—Net Mw not available.

Source: Florida Power Corporation, 1978.

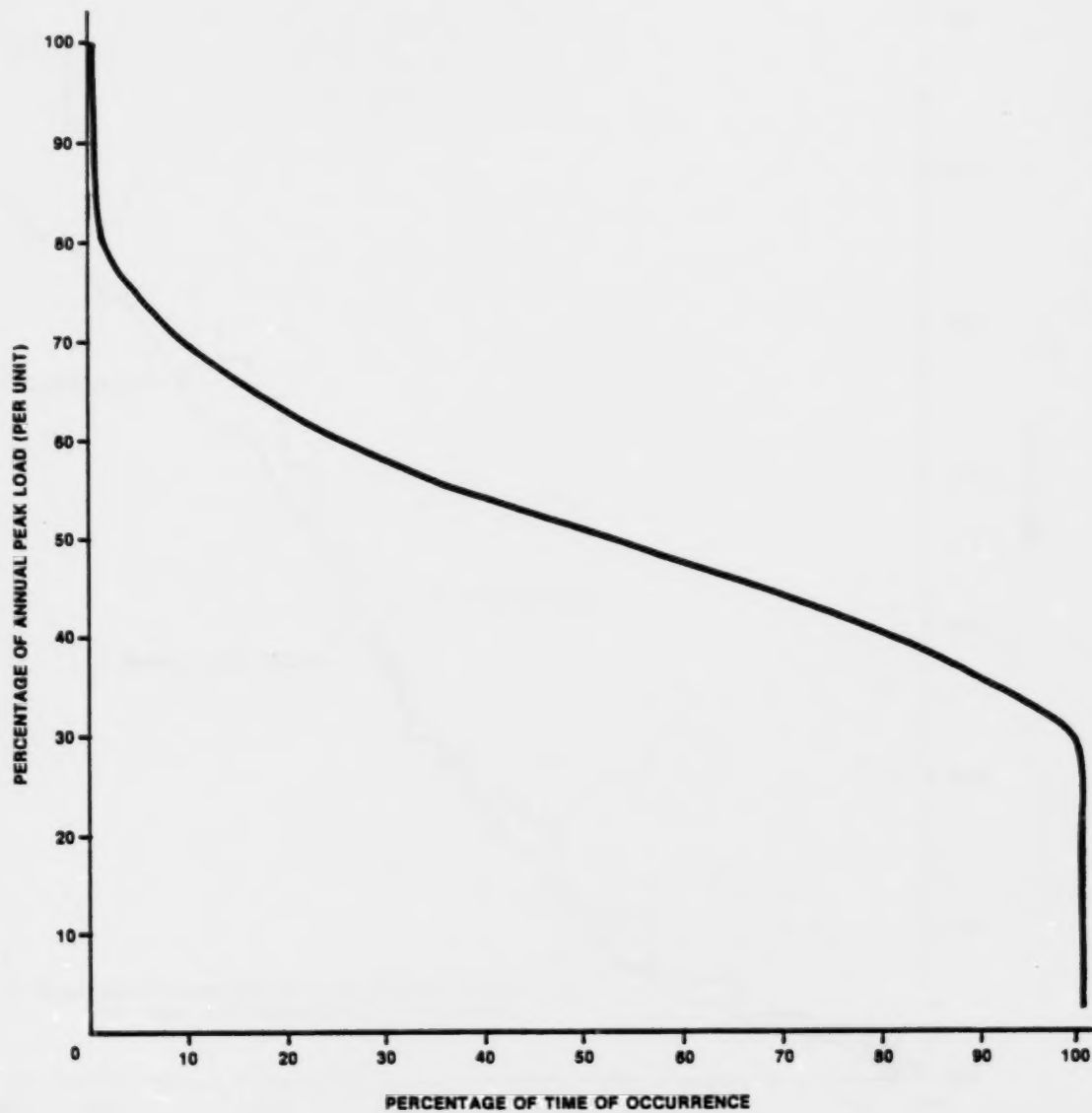


Figure 1.1-1
ANNUAL LOAD DURATION CURVE

SOURCE: FLORIDA POWER CORPORATION, 1978.

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

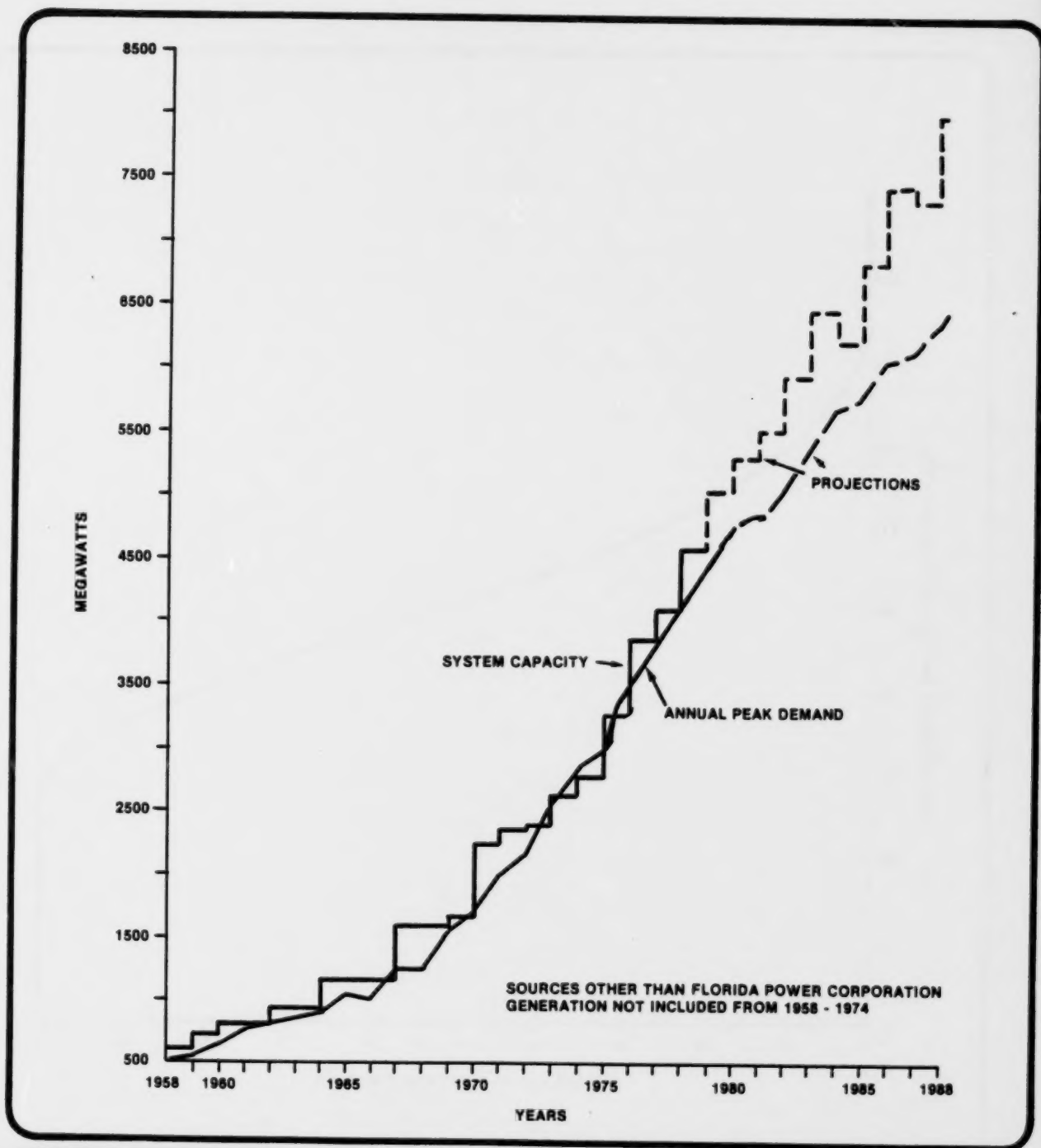


Figure 1.1-2
HISTORICAL AND PREDICTED PEAK DEMANDS AND
AVAILABLE GENERATION CAPACITY OF
FLORIDA POWER CORPORATION 1958 - 1988

SOURCE: FLORIDA POWER CORPORATION, 1980.

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

1.1.2 DEMAND PROJECTIONS

The first step in making a forecast is to arrive at a set of assumptions on which to base the forecast. These assumptions are determined first by a committee from the System Planning and Consumer Research Departments and then submitted to Florida Power executive management for approval and/or change as required. The following is the set of assumptions upon which the forecasts of energy use shown in Section 1.1.1 are based:

1. Normal weather conditions will prevail.
2. The economy of the service area will continue to improve at a slow, steady rate.
3. No significant loss of energy sales to solar energy will occur until the late 1980's.
4. Personal income will increase at a rate equal to or greater than the Consumer Price Index (CPI). Rate increases, if any, will be equal to or less than the CPI. No effects of rate increases will be included in the forecast.
5. Florida Power will continue to serve all of the wholesale load which they now serve as well as the energy required for the load growth of the existing wholesale customers, except the load and energy responsibility which will be assumed by Seminole Electric.
6. Unavailability of fossil fuels will cause an increase in use of electricity for space heating.
7. The population projections made by the Bureau of Economic and Business Research of the University of Florida in Population Studies, Bulletin No. 41, July 1977, are reasonably accurate.
8. There will be no impact of load management reflected in the forecast.
9. Improvements in insulation levels and equipment efficiency and increased emphasis on conservation will result in reduced sales beginning in the mid-1980's.

Customer projections in the forecast shown are based on the population projections published by the Bureau of Economic and Business Research, University of Florida, in Population Studies, Bulletin No. 41, dated July 1977. A linear regression of average annual residential customers and the population estimates of the 32 counties which constitute the service area yields the equation "Average Annual Residential Customers - $(0.2699) \times (\text{Service Area Population}) - 185,600$." This equation has a coefficient of determination of 0.9897.

The equation derived in this manner was used in conjunction with the population projections as a basis for the residential customer forecast. A similar regression of average annual residential customers and average annual commercial customers yields the equation "Commercial Customers = $(0.0944) \times (\text{Residential Customers}) + 7,615$." This equation has a coefficient of determination of 0.9966. This equation was used as a basis for the commercial customer forecast. The remaining classes of customers represent a small portion of the total, and these classes were forecast using trends.

The key indicator used in forecasting residential sales is annual kilowatt-hour consumption per customer. This indicator is forecast by two different methods, and the results are compared for consistency. The first method is a projection based on past trends, with some judgment of the effects of future events applied rather than using strictly rigorous mathematical methods. The second method used can be described as a disaggregate method. Sales to a "typical" residential customer are broken down by type of appliance such as air conditioning, heating, refrigeration, water heating, etc. The usage for each appliance is then combined with projections of appliance saturation to produce a forecast of kilowatt-hour sales per customer. The usage per appliance is based on in-house load research conducted over past years, when available, and on Edison Electric Institute published data when in-house data is not available. The kilowatt-hour sales per customer obtained by these two methods are then compared and a final estimate is made.

Commercial kilowatt-hour sales also are estimated by two different methods. Historical growth rates of total commercial sales are used to make projections of future growth rates. Sales figures obtained in this manner are compared to figures obtained by projecting historical kilowatt-hour sales per customer for future years and necessary adjustments are made to form the final forecast. Sales to the industrial, public authorities, and street and highway lighting classes are obtained by projections of historical growth rates.

The sales-for-resale class is forecast in two categories--Rural Electric Administrations (REA's) and municipals, and the total is obtained by adding the two. In past years, sales to the REA category have been closely related to the sales to the residential category. A regression of these two variables yields the equation "REA = (0.2383) x (Florida Power Corporation Residential Customers) - 325,700,000" and a coefficient of determination of 0.9951. In making the projections, however, the fact has been considered that the REA's serve in the more rural areas and therefore have greater potential for growth. Therefore, the final sales figures are a result of the regression equation tempered by judgment.

Similarly, sales to the municipal class historically have followed total sales excluding the sales to municipals. Using logic similar to that used for the REA sales, the municipal utilities serve in areas that are somewhat restricted, and therefore sales to this category are restrained in the later years of the forecast. The coefficient of determination for sales to municipals and total sales less municipals is 0.9775.

At this point in the forecasting process, total sales and total average annual customer forecasts have been determined; therefore, annual kilowatt-hour sales per customer can be calculated. A regression of the variables, annual kilowatt-hour sales per customer, and kilowatt demand per customer yields equations with coefficients of determination of 0.99 and 0.88 for summer and winter data, respectively. The equation

derived for summer demand per customer is "kw/Customer, Summer = $(2.5-14 \times 10^{-4}) \times (\text{kwh/Customer}) - 0.6290$," and the winter equation is "kw/Customer, Winter = $(2.0981 \times 10^{-4}) \times (\text{kwh/Customer}) + 0.1597$." These equations, again tempered by judgment, are used to determine the seasonal demand forecast. The annual load factor is then calculated to check the forecast for reasonableness.

At this time, a complete forecast has been determined which includes sales and demand of all wholesale load per assumption No. 5. However, it is known that several of the wholesale customers now own part of Crystal River Unit 3. The total of this unit now owned by the municipals is approximately 18.77 megawatts (Mw) and Seminole Electric owns about 14.02 Mw of the unit. An adjustment to these two categories is made by subtracting 164,400 mwh (18.77×8760) from the municipal sales and 12,800 mwh (14.02×8760) from the REA sales. The demand forecast is adjusted by subtracting 33 Mw from the total.

Seminole Electric has announced plans to build two 600 Mw coal units in the mid-1980's. Seminole Electric has furnished Florida Power with projections concerning the amount of load they intend to serve from these two units. This information has been used to adjust Florida Power's demand forecasts. At the present time, Seminole Electric plans to sell a portion of the output of each of these two units to other utility companies. The amount sold could be as high as 400 Mw from each unit when it is placed in service, but the amount sold will decrease steadily over a 10-year period. In the mid-1990's, the full combined rating of both units will be used to serve Seminole Electric's load. The following is a year-by-year schedule of the amount that Seminole Electric expects to sell from their units and the amount available to serve their own load:

<u>Year</u>	<u>Sold From Unit 1 (Mw)</u>	<u>Sold From Unit 2 (Mw)</u>	<u>Available to Serve Load (Mw)</u>
1983	400	N/A	200
1984	400	N/A	200
1985	400	400	400
1986	300	400	500
1987	300	400	500
1988	300	300	600
1989	200	300	700
1990	200	300	700
1991	100	200	900
1992	100	200	900
1993	0	100	1,100
1994	0	100	1,100
1995	0	0	1,200
1996	0	0	1,200
1997	0	0	1,200

The amounts shown in the "Available to Serve Load" column have been subtracted from the Florida Power load forecast to account for Seminole Electric taking over responsibility for their own load. The in-service dates of the Seminole Electric units are June 1, 1983, and June 1, 1985, and all changes in their capacity are assumed to occur on June 1 of each year. Sales to this category have also been adjusted by amounts consistent with their peak demand and load shape. Using this schedule, by 1986, Florida Power would have responsibility only for the peak 250-300 Mw of the Seminole Electric load. Due to the load duration curve associated with the Seminole Electric load, there would be a very small amount of energy associated with this amount of peak demand. Therefore, sales to the REA category have been reduced by an amount consistent with the demand assumptions and their load duration curve in the years 1983 through 1985, and are assumed to be zero in 1986 and each year thereafter.

Table 1.1-4 shows past and projected customer and sales growth rates in the most important categories and Table 1.1-5 shows past and projected demand growth rates. As can be seen from the table, future growth rates are projected to be considerably lower than historical rates. The lower customer growth rate is due to a reduction in the expected population growth rate for the Florida Power service area.

During the period 1967-1979, a tremendous growth in air conditioning saturation and other electric appliances took place that resulted in large sales and demand growth rates. Future growth in saturation of air conditioning is expected to be small simply because about 85 percent of the customers already have air conditioning. In addition, substantial increases in electric heat saturation which would produce a relatively high growth rate of winter demand are not expected due to the nature of heating requirements in Florida. The combined effects of a lower customer growth rate and reduced growth in kilowatt-hour sales per customer result in future growth rates of sales and demand that are substantially lower than historical.

Tables 1.1-6 and 1.1-7 show the accuracy of past forecasts made by Florida Power. In reviewing these tables, it is important to remember that forecasts are made to normal weather conditions. In many of the cases where the forecasts proved inaccurate, a large part of the deviation can be attributed to abnormal weather conditions.

It is also important to remember that the numbers shown in the forecast columns are expected values and are subject to a considerable amount of variability. Facility planning is not a deterministic process based on these numbers alone but is a conjectural process that takes load variability into account.

Table 1.1-4 Florida Power Corporation Customer Growth Rates and Sales Growth Rates

	CUSTOMER GROWTH RATES*			
	(%)			
	1957-1967	1967-1977	1977-1987	1987-1997
Residential	5.41	6.23	3.08	1.69
Total	5.20	6.14	2.99	1.68

	SALES GROWTH RATES*			
	(%)			
	1957-1967	1967-1977	1977-1987	1987-1997
Residential	12.64	11.41	4.91	2.41
Commercial	13.48	11.16	5.52	2.31
Industrial	10.53	5.78	5.64	2.83
Total (before Seminole adjustment)	11.30	10.31	5.59	2.56
Total (after Seminole adjustment)	N/A	N/A	4.29	2.43

*Growth rates are computed as compound annual percent changes.
N/A—Not applicable.

Source: Florida Power Corporation, 1978.

Table 1.1-5 Demand Growth Rates

	SUMMER DEMAND GROWTH RATES*				
	<u>1957-1967</u>	<u>1967-1977</u>	<u>1977-1987</u>	<u>1987-1997</u>	<u>1977-1997</u>
Before Seminole Adjustment	11.53	10.91	5.61	2.52	4.05
After Seminole Adjustment	N/A	N/A	4.67	1.66	3.15
	WINTER DEMAND GROWTH RATES*				
	<u>1956-57/1966-67</u>	<u>1966-67/1976-77</u>	<u>1976-77/1986-87</u>	<u>1986-87/1996-97</u>	<u>1976-77/1996-97</u>
Before Seminole Adjustment	7.96	12.89	5.74	2.79	4.25
After Seminole Adjustment	N/A	N/A	4.93	2.10	3.51

*Growth rates are computed as compound annual percent change.

N/A--Not applicable.

Source: Florida Power Corporation, 1978.

Table 1.1-6 Comparison of Forecast and Actual Peak Demands 1971-1973

Year	Season	1971 Forecast (Net Mw)	Percent Deviation*	1972 Forecast (Net Mw)	Percent Deviation	1973 Forecast (Net Mw)	Percent Deviation	Actual Adjusted Demand (Net Mw) †
1971-72	Winter	2,250	7.0					2,103
1972	Summer	2,410	- 3.5					2,497
1972-73	Winter	2,520	- 9.5	2,630	- 5.5			2,784
1973	Summer	2,640	-12.0	2,830	- 5.7			3,000
1973-74	Winter	2,790	- 6.7	2,950	- 1.3	3,100	3.7	2,989
1974	Summer	2,880	1.6	3,160	11.5	3,330	17.5	2,835
1974-75	Winter	3,090	2.7	3,280	9.0	3,440	14.3	3,010
1975	Summer	3,130	5.2	3,510	18.0	3,720	25.0	2,975
1975-76	Winter	3,390	- 5.8	3,640	1.1	3,860	7.2	3,600
1976	Summer	3,390	4.2	3,890	19.6	4,160	27.9	3,253
1976-77	Winter	3,700	-15.3	4,010	- 8.2	4,350	- 0.4	4,369
1977	Summer	3,630	4.6	4,300	23.9	4,640	33.7	3,470
1977-78	Winter	4,000	-3.3	4,420	6.9	4,870	17.8	4,135
1978	Summer	3,880	9.3	4,800	35.2	5,150	45.0	3,551
1978-79	Winter	4,320	1.6	4,860	14.2	5,480	28.8	4,254
1979	Summer	4,140	12.9	5,120	39.6	5,650	54.1	3,667
1979-80	Winter	4,640	-4.3	5,310	9.5	6,090	25.6	4,850

* Percent deviation is deviation of forecast over actual.
† Actual demand adjusted to include load curtailed at the time of system peak.

Source: Florida Power Corporation, 1978.

Table 1.1-7. Comparison of Forecast and Actual Peak Demands 1974-1976

Year	Season	1974 Forecast (Net Mw)	Percent Deviation*	1975 Forecast (Net Mw)	Percent Deviation	1976 Forecast (Net Mw)	Percent Deviation	Actual Adjusted † Demand (Net Mw)
1974-75	Winter	3,300	9.6					3,010
1975	Summer	2,890	- 2.9					2,975
1975-76	Winter	3,520	- 2.2	3,170	-11.9			3,600
1976	Summer	3,220	- 1.0	3,070	- 5.6			3,253
1976-77	Winter	3,800	-13.0	3,530	-19.2	3,860	-11.7	4,369
1977	Summer	3,450	- 0.6	3,320	- 4.3	3,440	- 0.9	3,470
1977-78	Winter	4,090	- 1.1	3,770	- 8.8	4,150	0.4	4,135
1978	Summer	3,710	4.5	3,540	- 0.3	3,700	4.2	3,551
1978-79	Winter	4,380	3.0	4,060	- 4.6	4,470	5.1	4,254
1979	Summer	3,990	8.8	3,750	2.3	3,990	8.8	3,667
1979-80	Winter	4,700	- 3.1	4,340	-10.5	4,810	- 0.8	4,850

* Percent deviation is deviation of forecast over actual.

† Actual demand adjusted to include load curtailed at the time of system peak.

Source: Florida Power Corporation, 1978.

1.1.3 POWER EXCHANGE

It is the policy of Florida Power to participate in mutually advantageous firm power exchanges with other electric utilities. This exchange of power can facilitate the generation expansion plans of both participating utilities. A firm exchange of power enables the selling utility to take advantage of the economies of scale by building larger and more economical units and enables the buying utility not only to defer capital investment but also to obtain peak generating capacity that is more efficient than combustion turbines. Thus, the exchange enables both utilities to supply their customers with reliable electric service for the lowest possible cost. At the present time, Florida Power has a contract with the City of Tallahassee for the purchase of 130 Mw during the winter season of 1979-80, with subsequent capacity schedules shown in Section 1.3. An agreement also has been signed with the Gainesville/Alachua County Regional Utilities Board that calls for purchase of 150 Mw during 1981-83.

In addition to these, agreements are also being negotiated with the City of Lakeland and the Orlando Utilities Commission (OUC) for firm power purchases in the early 1980's.

Florida Power is making every effort to take advantage of all the capacity available in the State of Florida in order to reduce the need for additional generation facilities in future years. Florida Power and Seminole Electric presently have a joint-venture generating plant. Seminole Electric owns part of Florida Power's Crystal River Unit 3. At this time, there are no firm commitments for future joint ownership of generating facilities between Florida Power and Seminole Electric. The 1985 and 1987 units of Florida Power still could develop into jointly owned units as could the 1985 Seminole Electric unit. It is Florida Power's position to actively pursue joint ownership.

1.2

SYSTEM CAPACITY

Florida Power uses two computer programs in the process of planning generation capacity. These two programs are the Corporate Model, and the Production Costing and Reliability Model known as PROMOD.

PROMOD is a reliability program that calculates the loss of load probability (LOLP).^{*} PROMOD is used to calculate the LOLP for each year; if the predetermined criterion for LOLP is exceeded in any year, the program calculates the amount of capacity that must be added in order to meet the criterion. The LOLP is calculated from a forecast of hourly peak demands and projected forced outage rates and scheduled outages for each generating unit. One of the most important inputs into the PROMOD program is the LOLP criterion. An LOLP of one day in 10 years has been generally accepted throughout the electric utility industry as a reasonable design goal. This criterion is being used at Florida Power, meaning there would be, on the average, one day in 10 years during which Florida Power would not be able to serve all of its firm load. For generation capacity planning purposes, it has been determined that a criteria of 2.5 days per year including dependency upon interruptible loads and interconnections is equivalent to the one day in 10 years LOLP for firm loads. After the PROMOD program has been used to determine the quantity and timing of required generation additions, expansion plans are developed for each reasonable combination of potential capacity additions. In order to evaluate these alternate expansion plans on a basis of equal reliability, PROMOD is used again to test and adjust each plan so that they do yield equal reliability.

^{*}Loss of Load Probability (LOLP)--is the probability that load exceeds capacity of a particular proposed generation system.

The next step in generation capacity planning is to determine, from a production costing standpoint, the cost to operate the system for each alternative expansion plan. The Production Costing Model, PROMOD, is also used to make this determination. Major inputs to PROMOD are an hourly demand and energy load model, estimated unit availability, heat rates and expected maintenance schedules for each unit, projected fuel cost for each type of fuel, and expected firm interchange information. Using this information, PROMOD determines the cost to operate the system for each alternate expansion plan.

Production costing information, capital cost estimate of each alternate plan, and kilowatt-hour sales forecast is input for the Corporate Model, which is a computer model of the financial operation of the company. The Corporate Model is used to determine the overall cost to the customer for each of the alternate expansion plans.

By going through this three-step process, the expansion plan that produces an acceptable system reliability at the lowest overall cost to the customer and still maintains a fair rate of return to the stockholder, as determined by the Florida Public Services Commission, is selected for future implementation.

1.3

RESERVE MARGINS

The proposed generation expansion plan for Florida Power is presented in Table 1.3-1.

Tables 1.3-2, 1.3-3, 1.3-4, and Figures 1.3-1, 1.3-2, and 1.3-3 are based upon the proposed generation expansion plan and demonstrate the effects of adding one 640 Mw coal unit in 1982, and another in 1984, on the Florida Power system and on the peninsula of Florida. As evident from the generation expansion plan, the addition of these two 640 Mw coal units is an important part of the overall Florida Power expansion plan through 1985. However, these units represent only one-half of the required capacity additions during the time period 1978 through 1985. The remaining additional capacity required is furnished by Anclote 2, 250 Mw combustion turbines, 300 Mw combined cycle, and purchases of firm capacity from neighboring utilities. Reductions in the previously stated forecasts in the period 1978-1985 are unlikely. However, in such a case, reduction of the generation expansion plan would be through delay and/or cancellation as required of the combustion turbine units which require a much shorter lead time than steam-type units. Thus, even if the load grows at a lower rate than predicted, the two coal units still are required and will result in a system that produces the lowest overall cost to the customer. Table 1.3-2 shows reserves and LOLP if both units are added. Table 1.3-3 shows comparable figures if the 1982 unit is omitted and the 1984 unit is retained. Table 1.3-4 shows the effects of omitting both units. In all cases, there are no scheduled outages of Florida Power units during the peak periods shown. Figures 1.3-1 through 1.3-3 present, in graphical form, the same information on peninsular Florida and Florida Power reserves and on Florida Power's LOLP.

Table 1.3-1. Florida Power Corporation General Expansion Plan

Year	Generating Capacity †	Additions (Mw)	Date	Reserves (%)
1980	5,275	50 Crystal River 2 (ID Fan) 130 Purchase (Tallahassee) *130 Purchase (Orlando)	4/79 4/79- 3/80 11/79-10/80	11.1
1981	5,530	150 Combustion Turbines 150 Purchase (Gainesville) 100 Purchase (Tallahassee) *115 Purchase (Orlando)	10/80 1/81-12/83 4/80- 3/81 11/80-10/81	9.5
1982	5,985	300 Combined Cycle *200 Purchase (Lakeland) * 90 Purchase (Orlando) 80 Purchase (Tallahassee)	10/81 10/81-11/82 11/81-10/82 4/81- 3/82	11.7
1983	6,485	640 Coal (Crystal River 4) *170 Purchase (Lakeland) 60 Purchase (Tallahassee)	10/82 12/82-11/83 4/82- 3/83	14.6
1984	6,235	100 Combustion Turbines 30 Purchase (Tallahassee)	10/83 4/83- 3/84	8.2
1985	6,845	640 Coal (Crystal River 5)	4/84	13.1
1986	7,441	640 Coal Unit (44) Avon Park 2 Retired	10/85	21.2
1987	7,374	(67) Suwannee 1, 2 Retired	6/86	16.9
1988	8,014	640 Coal Unit	10/87	21.8

*Contracts presently under negotiation.

†Generating capacity at time of winter peak is calculated as follows:

For generating capacity 1981, 5,530 Mw is obtained by subtracting the 130 Mw Tallahassee purchase, which expires 3/80, and the 130 Mw Orlando purchase, which expires 10/80, from the 1980 generating capacity of 5,275 Mw and then adding 150 Mw combustion turbines, 150 Mw Gainesville purchase, 100 Mw Tallahassee purchase, and 115 Mw Orlando purchase.

Source: Florida Power Corporation, 1978.

Table 1.3-2. Capacity, Demands, and Reserves for Peninsular Florida and Florida Power Corporation (With Crystal River Units 4 and 5 Included)

Year	Capacity		Winter † Peak Demand		Reserves		FPC LOLP Days/Year
	State	FPC *	State	FPC	State Mw	FPC Mw	
1980	24,483	5,275	19,598	4,750	4,885	525	11.1
1981	26,270	5,530	20,769	5,050	5,501	480	9.5
1982	26,910	5,985	21,895	5,360	5,015	625	11.7
1983	29,015	6,485	22,996	5,660	6,019	825	14.6
1984	28,401	6,235	24,082	5,760	4,319	475	8.2
1985	31,412	6,845	25,232	6,050	6,180	795	13.1
1986	31,934	7,441	26,390	6,140	5,544	1,301	21.2
1987	33,374	7,374	27,592	6,310	5,782	1,064	16.9

* FPC capacity includes firm power purchases where applicable and is that value of capacity in the month of January for each respective year.

† Winter peak is assumed to occur in January of each year.

Source: Florida Power Corporation, 1978.

Table 1.3-3. Capacity, Demands, and Reserves for Peninsular Florida and Florida Power Corporation (With Crystal River Unit 4 Omitted and Crystal River Unit 5 Included)

Year	Capacity		Winter † Peak Demand		Reserves			FPC LOLP Days/Year
	State	FPC *	State	FPC	State Mw	%	FPC Mw	
1980	24,483	5,275	19,598	4,750	4,885	24.9	525	11.1
1981	26,270	5,530	20,769	5,050	5,501	26.5	480	9.5
1982	26,910	5,985	21,895	5,360	5,015	22.9	625	11.7
1983	28,375	5,845	22,996	5,660	5,379	23.4	185	3.3
1984	27,761	5,595	24,082	5,760	3,679	15.3	-165	-2.85
1985	30,772	6,205	25,232	6,050	5,540	22.0	155	2.55
1986	31,294	6,801	26,390	6,140	4,904	18.6	661	10.8
1987	32,734	6,734	27,592	6,310	5,142	18.6	424	6.7

* FPC capacity includes firm power purchases where applicable and is that value of capacity in the month of January for each respective year.

† Winter peak is assumed to occur in January of each year.

Source: Florida Power Corporation, 1978.

Table 1.3-4. Capacity, Demands, and Reserves for Peninsular Florida and Florida Power Corporation (With Crystal River Units 4 and 5 Omitted)

Year	Capacity		Winter † Peak Demand		Reserves			FPC LOLP Days/Year
	State	FPC *	State	FPC	State Mw	%	FPC Mw	
1980	24,483	5,275	19,598	4,750	4,885	24.9	525	11.1
1981	26,270	5,530	20,769	5,050	5,501	26.5	480	9.5
1982	26,910	5,985	21,895	5,360	5,015	22.9	625	11.7
1983	28,375	5,845	22,996	5,660	5,379	23.4	185	3.3
1984	27,761	5,595	24,082	5,760	3,679	15.3	-165	-2.9
1985	30,132	5,565	25,232	6,050	4,900	19.4	-485	-8.0
1986	30,654	6,161	26,390	6,140	4,264	16.2	21	0.3
1987	32,094	6,094	27,592	6,310	4,502	16.3	-216	-3.4
								14.1

* FPC capacity includes firm power purchases where applicable and is that value of capacity in the month of January for each respective year.

† Winter peak is assumed to occur in January of each year.

Source: Florida Power Corporation, 1978.

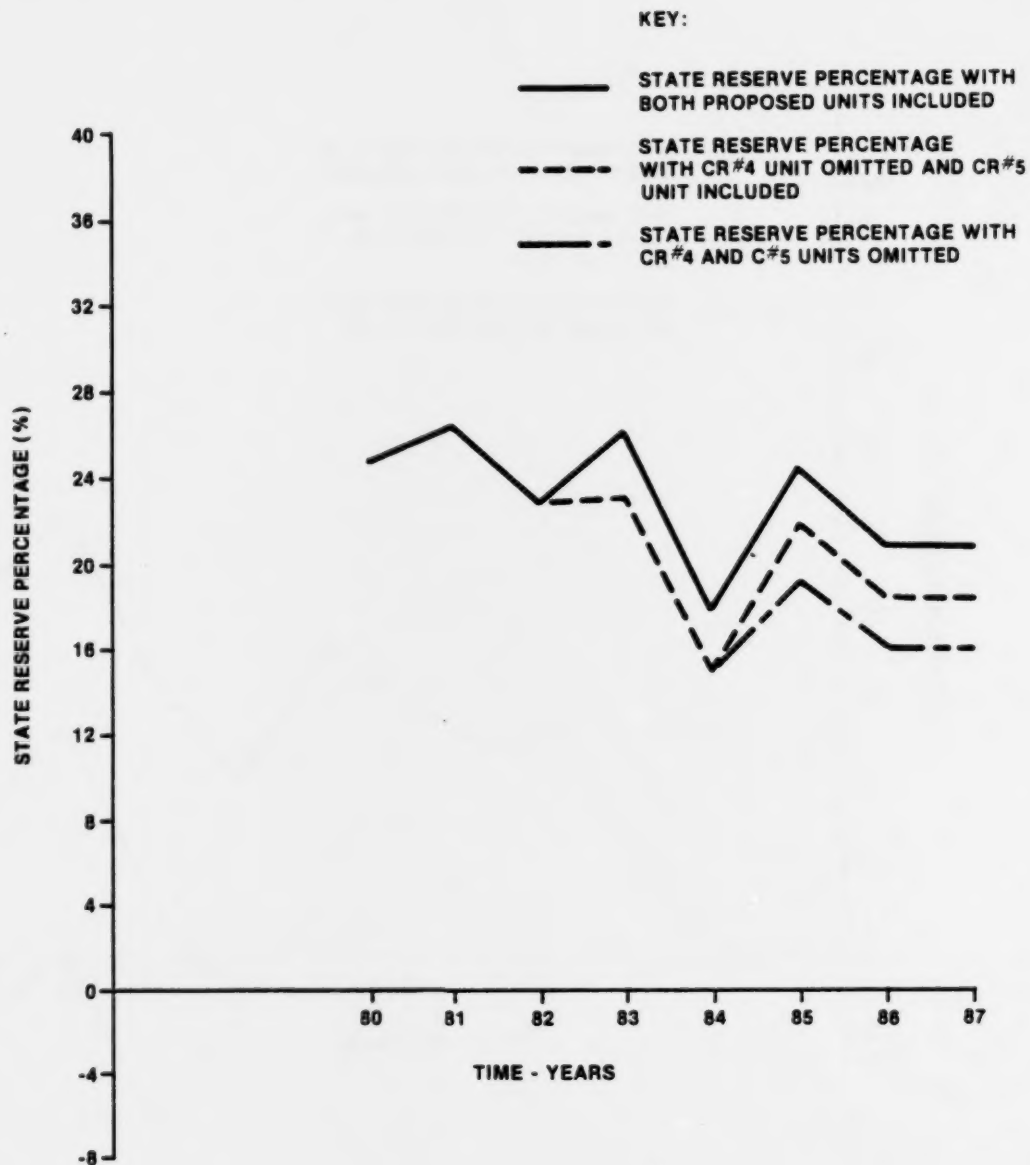


Figure 1.3-1
PENINSULAR FLORIDA PERCENT RESERVES

SOURCE: FLORIDA POWER CORPORATION, 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

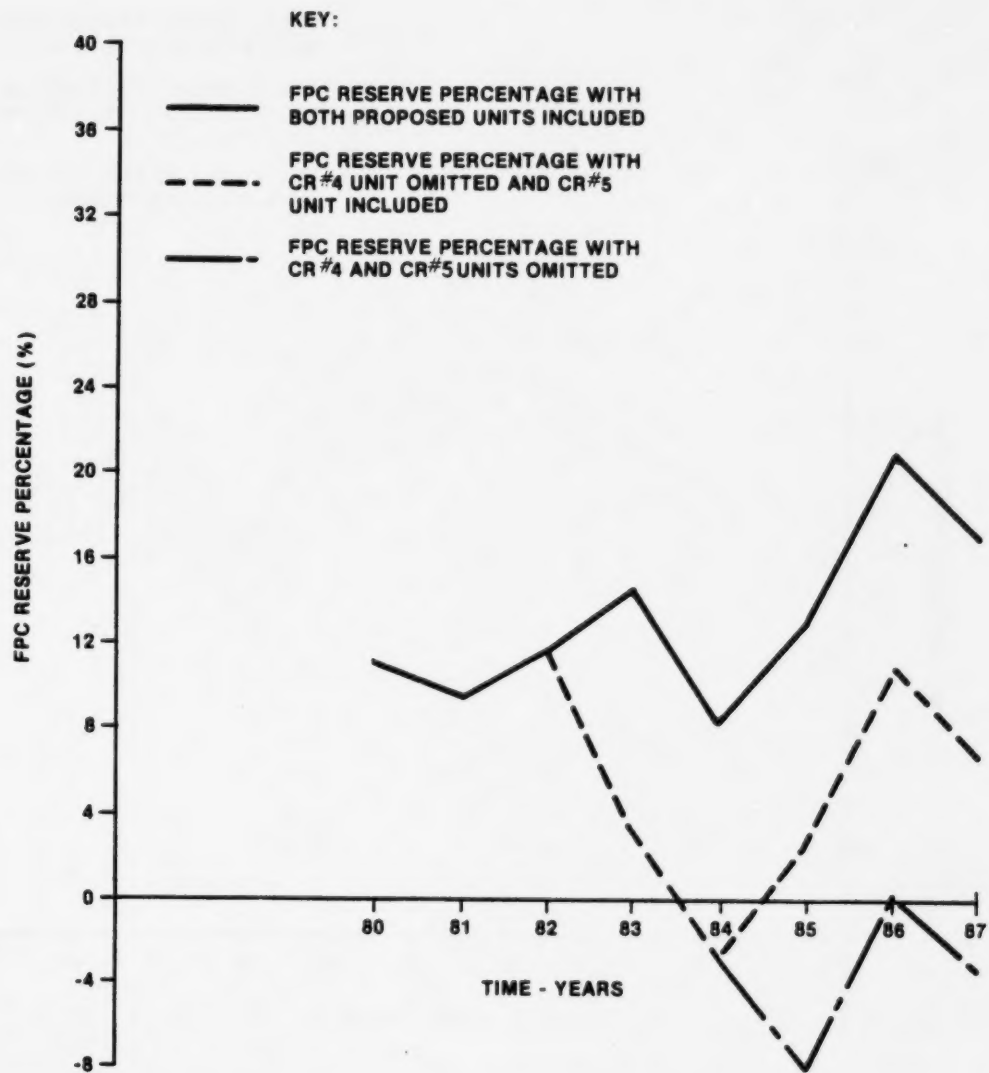


Figure 1.3-2
FLORIDA POWER CORPORATION PERCENT RESERVES

SOURCE: FLORIDA POWER CORPORATION, 1978.

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

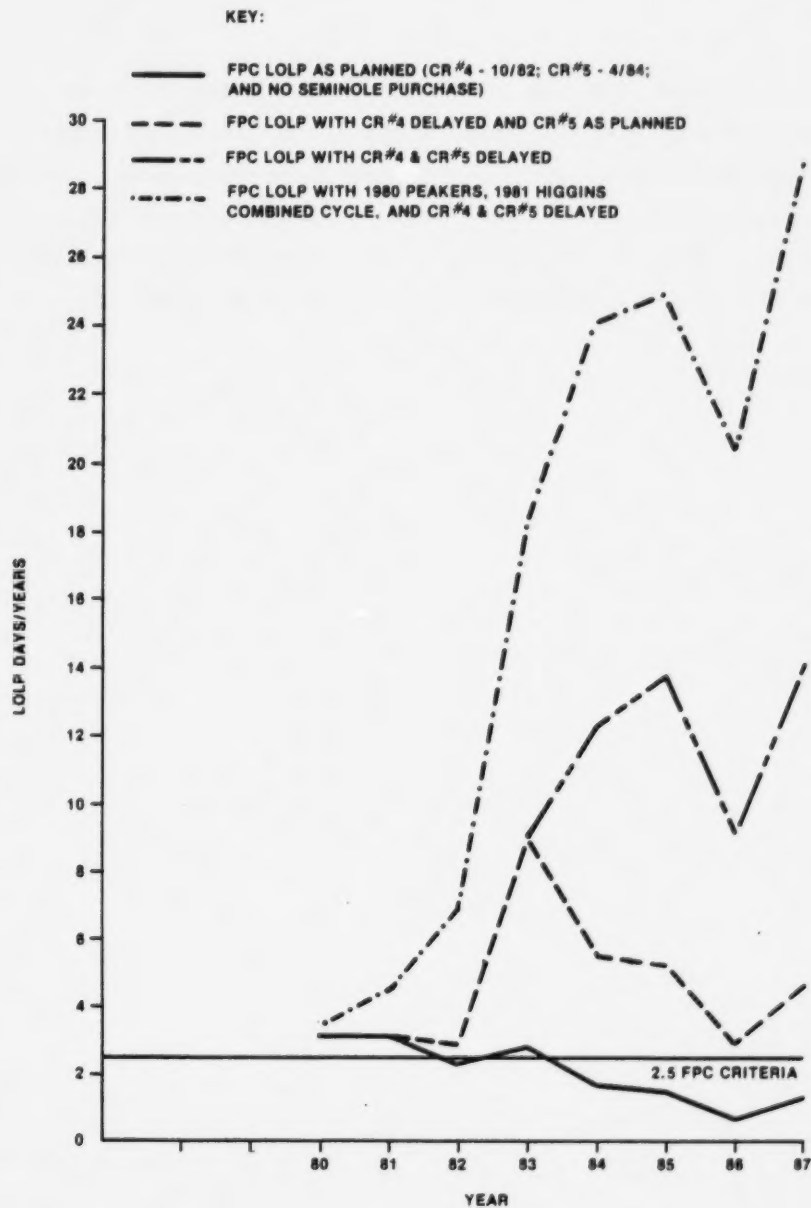


Figure 1.3-3
FLORIDA POWER CORPORATION LOSS OF LOAD
PROBABILITY

SOURCE: FLORIDA POWER CORPORATION, 1978.

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

As can be seen from the tables and figures, Florida Power's reserves and LOLP have unacceptable values without the additional capacity provided by the two proposed units or by some other firm capacity source or combination of sources. A discussion of Florida Power's LOLP criterion and how it is used in conjunction with interconnections and interruptible load for planning purposes is contained in Section 1.2.

1.4

OTHER OBJECTIVES

At the present time, the sole objective of the two proposed units is to produce electricity.

1.5

CONSEQUENCES OF DELAY

As discussed previously, loss of load probability is one method used by the electric utility industry to evaluate the adequacy of reserve capacity levels in generation expansion planning. In this context, LOLP also can be used to describe and evaluate the effects of changes in system generation capacities. An LOLP index of one day in ten years for firm load calculated on an interconnected system basis has been generally accepted as a reasonable goal by the electric utility industry. A value of approximately 2.5 days per year dependency upon tie lines and/or interruptible loads has been determined as an acceptable equivalent index for the Florida Power system and is used as the basis for evaluating the consequences of generation capacity changes.

Tables 1.3-2 and 1.3-3 and Figure 1.3-3 show that if the proposed project were delayed, the LOLP index for the Florida Power system would greatly exceed acceptable values in the period 1983 to 1987. If the proposed unit is not installed in 1982 as planned, this index will jump from 2.8 to 9.0 in 1983. Figure 1.3-3 illustrates the continued effect on system reliability in terms of days per year if only the proposed Crystal River Unit 4 were deleted from the proposed generation expansion plan. Figure 1.3-3 includes the addition of 450 Mw of additional peaking and combined cycle capacity to the Florida Power system prior to the addition of the proposed Crystal River Unit 4. In addition, firm capacity purchases from other utilities during the time period 1979-1983, and subsequent 640 Mw coal capacity additions in 1984, 1985, and every second year thereafter are shown. The details of the Florida Power generation expansion plan were presented in Section 1.3.

Figure 1.3-3 shows that in the subsequent 7-year period without installation of the proposed Crystal River Unit 4, the LOLP exceeds

acceptable values, even if all other proposed generation additions and firm capacity purchases were installed as planned and scheduled. The deviation of LOLP from acceptable values would be even greater if the proposed Crystal River Unit 5 were also omitted.

Figure 1.5-1 shows the effects on Florida Power's LOLP of delaying the other proposed generation additions and firm capacity purchases from other utilities even if Crystal River Units 4 and 5 are installed as planned. Since the other proposed generation additions have not yet been licensed, there is a possibility that the 450 Mw of additional peaking and combined cycle capacity that they represent may be delayed due to licensing or construction problems. Figure 1.5-1 shows the effect on system reliability in terms of days per year if just the 450 Mw of combustion turbines and combined cycle units were omitted (or indefinitely delayed) from the proposed generation expansion plan. As shown in Figure 1.5-1, if the combustion turbines and combined cycle units are delayed or omitted from the generation expansion plan and the Crystal River Units 4 and 5 are added, the LOLP exceeds acceptable values. If the 1980 combustion turbines and 1981 combined cycle units are not installed, the LOLP exceeds 6 days per year in 1983 and does not reach Florida Power's LOLP criterion of 2.5 days per year until 1986.

As mentioned previously, Florida Power plans to purchase firm capacity from neighboring utilities (Section 1.3). All previous figures and discussions include these firm purchases which reach peaks of 550 Mw and 370 Mw in 1981 and 1982, respectively. Since some of these purchases are based on the addition of new units by other utilities, there is a possibility that these purchases could be delayed. Also, Figure 1.5-1 shows the effect on system reliability in terms of days per year if only the Lakeland, Gainesville, and Orlando purchases were omitted from the proposed generation expansion plan. As shown in Figure 1.5-1, the omission of the Lakeland, Gainesville, and Orlando purchases has the effect of doubling the "as planned" system LOLP during the time period 1981 through 1983.

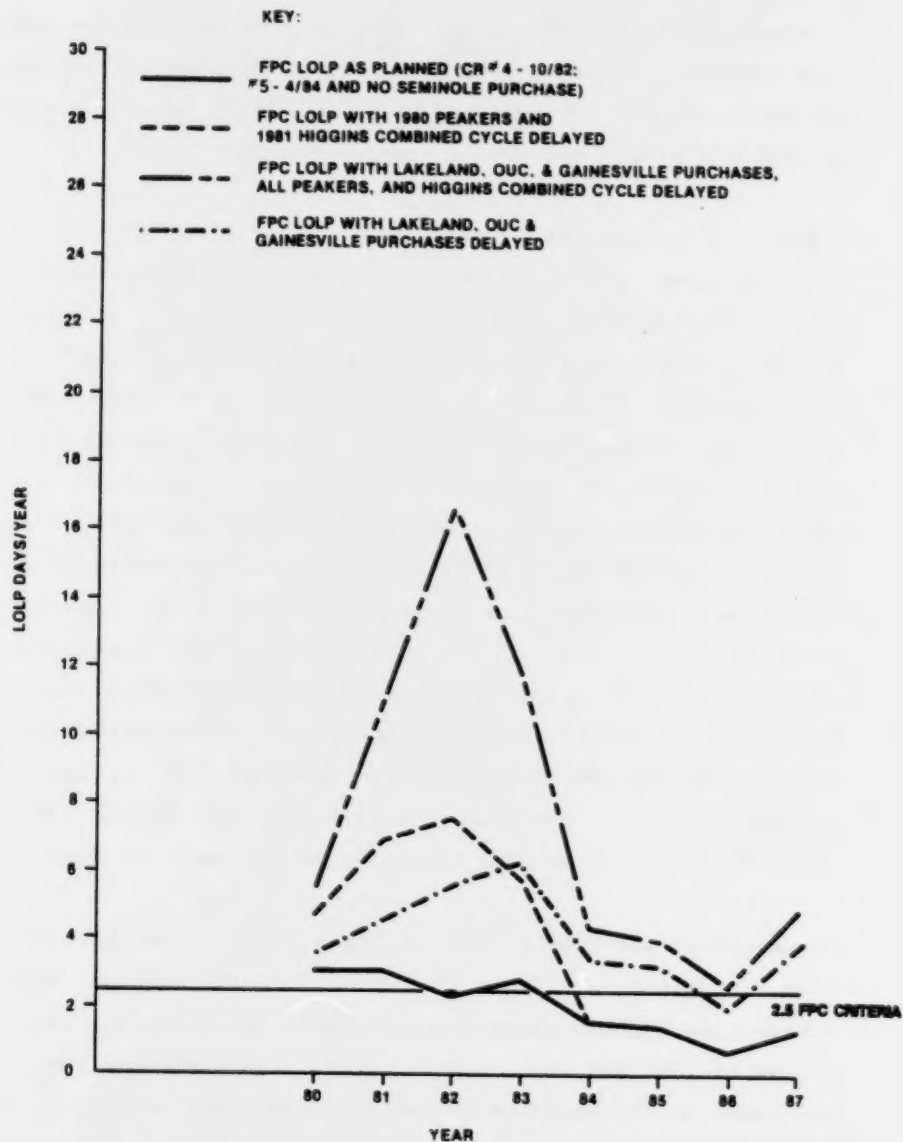


Figure 1.5-1
FLORIDA POWER CORPORATION LOSS OF LOAD
PROBABILITY

SOURCE: FLORIDA POWER CORPORATION, 1978.

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

In addition, Figure 1.5-1 shows the effect on the Florida Power system LOLP if the 1980 combustion turbines and the 1981 combined cycle units are not installed along with the omission of the Lakeland, Gainesville, and Orlando purchases. As shown, the LOLP exceeds 16 days per year in 1982, even with the addition of Crystal River Unit 4 in October of that same year.

The addition of Crystal River Units 4 and 5 is essential and considered a minimum requirement for the Florida Power system. If neither the 450 Mw combustion turbines and combined cycle units nor the Crystal River Units 4 and 5 are installed as planned, the LOLP exceeds 24 days per year by 1984 and 28 days per year by 1987 (Figure 1.3-3).

As shown in Figure 1.5-2, a possible alternative to the Florida Power facility expansion plan is the delay of Crystal River Unit 5 until October 1985, with the purchase of 300 Mw from Seminole Electric Cooperative, Inc., from October 1983 to October 1986 and the delay of the Florida Power 1985 coal unit until October 1986. Also shown in Figure 1.5-2 is the effect on the Florida Power LOLP if the Crystal River Unit 5 and Seminole Electric units are delayed. It should be noted that the Seminole Electric delay not only deprives the Florida Power system of 300 Mw of planned capacity purchase but also increases the Florida Power load responsibility by 200 Mw. In this case, the Florida Power LOLP rises to 5.5 days per year in 1984 and exceeds 10 days per year by 1987. It is important to note that there are substantial risks associated with the reliance on firm purchases from other utilities (i.e., Lakeland, Gainesville, and Orlando) during the time period 1981 to 1984. As shown in Figure 1.5-1, if these purchases are delayed, in 1982 the Florida Power LOLP exceeds 7 days per year even with the addition of Crystal River Unit 4 in October 1982 and 5 days per year in 1983. Since the possibility exists that these purchases (i.e., Lakeland, Gainesville, Orlando, and Seminole) may not materialize as scheduled and that problems in the licensing and construction of the 1980 combustion turbines and 1981 combined cycle units may also result

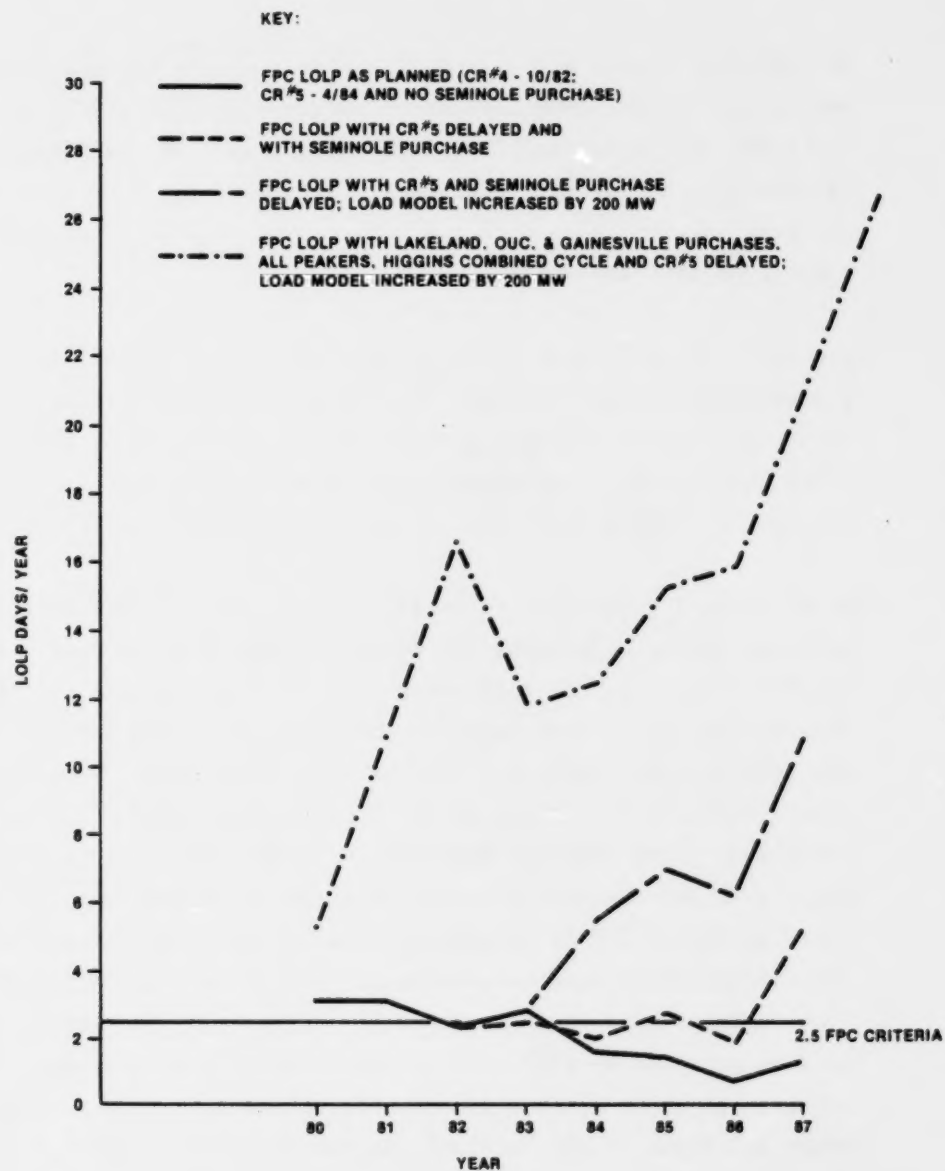


Figure 1.5-2
FLORIDA POWER CORPORATION LOSS OF LOAD
PROBABILITY

SOURCE: FLORIDA POWER CORPORATION, 1978.

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

in delays, flexibility is essential in the scheduling to bring Crystal River Unit 5 on-line as early as possible in order to assure a reliable supply of electric service to Florida Power customers.

These figures, like all LOLP figures, are an index of system reliability. They are not to be interpreted as a prediction of the actual days of load interruption or emergency tie line interchange expected during some future year. They are strictly probability figures; that is, if the year 1983 were to repeat over and over, it is expected that, on the average, there would be 2.8 days per year that the Florida Power system would be lacking sufficient generation to cover its total load, and thus would be dependent upon emergency interchange availability and the shedding of interruptible loads. Without the proposed Crystal River Unit 4, this figure rises to 9 days per year.

If, in a given situation, the sum total of available emergency power and interruptible load on the system is insufficient to cover the deficit, the loss of firm loads within the Florida Power system is inevitable. As a general practice, the electrical utilities within the United States have attempted to minimize to one day in ten years such loss of firm load due to generation capacity deficiencies. Joint studies conducted within the State of Florida indicate that with the proposed generation facilities plan, this reliability goal can be accomplished. If the recommended capacities are delayed or adequate substitute capacities are not provided, the figures indicate there would probably be more frequent instances of blackouts and/or brownouts within the Florida Power service area. Outages due to lack of generation capacity have a much more severe impact upon the communities served by the company than do interruptions to individual customers or small groups of customers.

1.6

ADDENDUM TO CHAPTER I

1.6.1 GENERAL COMMENTS

The preliminary Draft Environmental Impact Statement (PDEIS) was prepared in late 1977 and submitted during the first part of 1978. Since that time, a number of changes in the forecasts and expansion plans have taken place which alter the projections of capacity reserve margin and reliability indices contained in the PDEIS and TSD. The purpose of this addendum is to describe the salient changes and assess their impact on the original projections.

LOAD ANALYSIS

The current forecast of energy use is somewhat lower than the forecast contained in Table 1.1-2 of the TSD. For the purpose of comparison, the original and current forecasts of Net Energy for Load (NEL) for 1980-1985 are:

<u>Year</u>	<u>Original NEL Forecast (GWH)</u>	<u>Current NEL Forecast (GWH)</u>	<u>Difference (%)</u>
1980	21,090	18,944	10%
1981	22,411	20,208	10%
1982	23,741	21,632	9%
1983	23,805	22,425	6%
1984	24,347	23,403	4%
1985	25,802	24,121	7%

Actual NEL Figures in 1977-79 were lower than forecast and resulted in a reduction of the energy forecast.

DEMAND PROJECTIONS

A comparison of original demand projections to current projections indicates a slight reduction in summer peak demands in 1980-83 but no change in the winter peak projection, which is the system peak load projection.

Actual winter peaks in 1977-79 met or exceeded the original projections. The 1979-80 winter peak of 4,850 Mw (adjusted for curtailments) exceeded the forecast by 100 Mw.

Year	Summer Forecast (Mw)		Year	Winter Forecast (Mw)	
	Original	Current		Original	Current
1980	4,190	3,900	1980-81	5,050	5,050
1981	4,440	4,220	1981-82	5,360	5,360
1982	4,710	4,710	1982-83	5,660	5,660
1983	4,750	4,750	1983-84	5,760	5,760
1984	4,950	4,950	1984-85	6,050	6,050
1985	5,030	5,030	1985-86	6,140	6,140

The original and current forecasts contain the same assumptions regarding the transfer of load to the Seminole units when they are completed in 1983 and 1985.

POWER EXCHANGE

Presently, Florida Power Corporation has 200 Mw under contract from Southern Company (1/80-12/86); 150 Mw (1/81-12/84), 125 Mw (1/85-11/85), 100 Mw (1/86-12/86) from Gainesville; 200 Mw (10/81-11/82), 170 Mw (12/82-11/83), 140 Mw (12/83-11/84), 100 Mw (12/84-11/85) from Lakeland; and 100 Mw (4/80-3/81), 80 Mw (4/81-3/82), 60 Mw (4/82-3/83), 30 Mw (4/83-3/84) from Tallahassee.

1.6.2 SYSTEM CAPACITY

Florida Power Corporation's planning methodology of using PROMOD and Corporate Model computer simulations for the determination of system capacity has not changed.

1.6.3 RESERVE MARGINS

The timing and type of capacity additions shown in Table 1.3-1 Florida, Power General Expansion Plan, have changed since 1978. Currently, Crystal River Unit No. 3 and Anclote Unit No. 2 are both in service. The timing of contracted purchases is discussed in Section 1.1.3, Power Exchange. The combined cycle units (300 Mw) scheduled for 10/81 have

been cancelled. The Crystal River Unit No. 4 coal unit (640 Mw) scheduled for 10/82 has been deferred to 12/82. The 100 Mw of combustion turbines scheduled for 10/83 have been cancelled. The Crystal River Unit No. 5 coal unit (640 Mw) scheduled for 4/84 has been deferred until 12/84. The 800 Mw coal unit* scheduled for 10/85 has been deferred until 12/87. The 800 Mw coal unit* scheduled for 10/87 has been changed to 12/89.

The capacity, demand, and reserves for Peninsula Florida and Florida Power Corporation shown in Table 1.3-2 have been changed as follows:

Year	Capacity		Winter Peak Demand		Reserves			
	State	FPC	State	FPC	State		FPC	
					MW	%	MW	%
1981	24,442	5,579	19,607	5,050	4,835	24.7	529	10.5
1982	26,124	5,759	20,554	5,360	5,570	27.1	399	7.4
1983	26,131	5,709	21,706	5,660	4,425	20.4	49	1.0
1984	28,276	6,319	22,497	5,760	5,779	25.7	559	9.7
1985	28,914	6,894	23,734	6,050	5,180	21.8	844	14.0
1986	30,015	6,731	25,721	6,140	5,294	21.4	591	9.6
1987	30,691	6,431	25,684	6,280	5,007	19.5	151	2.4

As seen from this update, the projected state capacity by 1987 is approximately 2,600 Mw less than projected previously. However, the projected state peak demand also is approximately 2,000 Mw less than previously projected and, therefore, does not affect the percent reserves. This situation is not the case for Florida Power Corporation. As seen from this update and previous discussion of Table 1.3-1, Florida Power Corporation's megawattage of available reserves is somewhat lower due to the deferral and cancellation of future generation.

Although a new analysis has not been made to update the FPC LOLP (Days/Year), it can be inferred from the above information that the loss of load probability would increase due to the declining reserves of the Florida Power system.

* Florida Power Corporation's share of these joint participation units will be 640 Mw.

1.6.4 OTHER OBJECTIVES

This section is unchanged. The sole objective of the two proposed units is to produce electricity.

1.6.5 CONSEQUENCES OF DELAY

As mentioned earlier, Florida Power Corporation's projected available capacity to serve load is somewhat less than previously projected, due to the cancellation and deferral of generating capacity. This cancellation will result in a higher loss of load probability; therefore, the results discussed in this section will only increase in magnitude and make the installation of these two units more important to Florida Power Corporation for maintaining a reliable generating system for its customers.

CHAPTER 2

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
2.0 <u>THE SITE</u>	2-1
2.1 SITE LOCATION AND LAYOUT	2-1
2.2 REGIONAL DEMOGRAPHY, LAND, AND WATER USE	2-4
2.2.1 Five-Mile Radius Map	2-4
2.2.2 Population of Citrus County and the Five-Mile Radius Area	2-6
2.2.3 Present and Projected Land Use	2-9
2.2.4 Zoning Restrictions	2-12
2.3 REGIONAL HISTORIC, SCENIC, CULTURAL, AND NATURAL LANDMARKS	2-14
2.3.1 History	2-14
2.3.2 Archaeological and Historical Sites	2-16
2.3.3 Scenic and Natural Landmarks	2-19
2.4 GEOLOGY	2-20
2.4.1 Site Description	2-20
2.4.2 Physiography	2-21
2.4.3 Stratigraphy	2-22
2.4.4 Soils	2-28
2.4.5 Flooding	2-29
2.5 HYDROLOGY	2-30
2.5.1 Ground water	2-30
2.5.2 Surface Water	2-47
2.5.3 Water Resources Specific to the Proposed Site for Units 4 and 5	2-71
2.6 CLIMATOLOGY AND DISPERSION METEOROLOGY	2-73
2.6.1 Temperature	2-74
2.6.2 Precipitation and Humidity	2-76
2.6.3 Wind and Stability	2-78
2.6.4 Severe Storms	2-90
2.6.5 Mixing Depths	2-91

CHAPTER 2

TABLE OF CONTENTS
(Continued, page 2 of 2)

<u>Section</u>		<u>Page</u>
2.7	ECOLOGY	2-93
	2.7.1 Introduction	2-93
	2.7.2 Terrestrial Ecosystem Analysis	2-95
	2.7.3 Aquatic Ecosystem Analysis	2-166
	2.7.4 Rare and Endangered Species	2-183
	2.7.5 Functionally Critical Species	2-204
	2.7.6 Predicted Future Environment Without the Proposed Plant	2-205
2.8	AMBIENT AIR	2-206
	2.8.1 Ambient Air Standards	2-206
	2.8.2 Ambient Air Sampling Program	2-208
	2.8.3 Dispersion Modeling	2-213
	2.8.4 Baseline Air Quality	2-215
2.9	OTHER ENVIRONMENTAL FEATURES	2-217
	2.9.1 Noise	2-217
	2.9.2 Natural Sea Salt	2-232

CHAPTER 2

LIST OF TABLES

<u>Table</u>		<u>Page</u>
2.2-1	Population of Citrus and Levy Counties, Their Municipalities, and Florida, April 1, 1970 Census and July 1, 1977 Estimates	2-7
2.4-1	Plant Site Area Soil Boring	2-24
2.5-1	Present and Projected Future Water Demands in Citrus County in Millions of Liters Per Day (Millions of Gallons Per Day)	2-41
2.5-2	USGS Streamgaging Network in Vicinity of Proposed Plant	2-49
2.5-3	Lake Stages in Vicinity of Proposed Plant	2-50
2.5.3a	FAC 17-3 Water Quality Criteria--General and Class III (17-3.121)	2-60
2.5-4	Water Quality Analysis--Crystal River and Lake Rousseau (Samples taken August 29, 30, 1977)	2-66
2.5-5	Analyses of Water from Test Borings in the Proposed Plant Site Area and Existing Site	2-72
2.6-1	Monthly Means and Extremes of Temperature (°C) for Crystal River, Florida	2-75
2.6-2	Monthly Means and Extremes of Precipitation (Millimeters) and Relative Humidity for Crystal River, Florida	2-77
2.6-3	Relative Frequency Distribution of Wind Speed and Direction, Crystal River, Florida	2-83
2.6-4	Frequency of Occurrence of Pasquill's Stability Classes, Crystal River Site, 1975	2-89
2.6-5	Mean Diurnal Mixing Depth (Meters), Tampa International Airport, Tampa, Florida	2-92
2.7-1	Plant Community Composition of Proposed Plant and Region in Acres and Percent of Vegetated Area	2-98
2.7-2	Plant Community Composition Within an 8-Kilometer (5-Mile) Radius of Plant Site	2-99

CHAPTER 2

LIST OF TABLES
(Continued, page 2 of 3)

<u>Table</u>		<u>Page</u>
2.7-3	Plant Communities of the Proposed Plant Site	2-101
2.7-4	Plant Species Found in Pine Flatwoods Section of Proposed Site During Summer 1977 Survey	2-105
2.7-5	Plant Species Found in Mesic Hammock/Hydric Hammock Section of Proposed Site During Summer 1977 Survey	2-107
2.7-6	Plant Species Found in Freshwater Marsh on Proposed Site During Summer 1977 Survey	2-109
2.7-7	Plant Species Found in the Ground Cover of Pine Plantations of Proposed Site During Summer 1977 Survey	2-112
2.7-8	Plant Species Found in Ruderal Areas of Proposed Site During Summer 1977 Survey	2-113
2.7-9	Plant Species Found in Coastal Hydric Hammock Section of Proposed Site During Summer 1977 Survey	2-117
2.7-10	Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur on or in the Vicinity of the Proposed Plant Site, Citrus County	2-121
2.7-11	Qualitative Small Mammal Trapping From Habitats at the Proposed Site: August 1977	2-137
2.7-12	Microarthropods in the Vicinity of the Crystal River Marsh System	2-169
2.7-13	Fish Previously Caught in the Crystal River Marsh Area	2-173
2.7-14	Organisms Collected at Aquatic Sampling Stations Along Three Transects at the Proposed Plant Site	2-181

CHAPTER 2

LIST OF TABLES
(Continued, page 3 of 3)

<u>Table</u>		<u>Page</u>
2.7-15	Rare and Endangered Plant Species Reported in The Crystal River Region	2-185
2.7-16	Rare and Endangered Animal Species Which May Occur in the Vicinity of the Crystal River Property	2-190
2.7-17	Manatee Sightings Reported Near the Crystal River Site to U.S. Fish and Wildlife for 1974-1976	2-202
2.8-1	State of Florida Air Quality Standards	2-207
2.8-2	Summary of Non-Continuous 24-Hour TSP and SO ₂ Ambient Air Quality Data, Florida Power Corporation Crystal River Site, May 7, 1977 through April 26, 1978	2-210
2.8-3	Summary of the Continuous SO ₂ Data, Florida Power Corporation, Crystal River, Florida, July 1 through January 25, 1978 (Results in ug/m ³)	2-211
2.8-4	Maximum Estimated Baseline Concentrations (ug/m ³) in the Vicinity of Florida Power Corporation's Crystal River Site, and at the Chassahowitzka Wilderness Area Units 1 and 2 on 2.7 percent Sulfur Fuel Oil and at 0.1 lb. TSP/10 ⁶ Btu	2-216
2.9-1	Federal Highway Administration Design Noise Level/Land Use Relationships	2-222
2.9-2	Yearly Average Equivalent Sound Levels Identified as Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety	2-223
2.9-3	Locations and Characteristics of Noise Monitoring Stations	2-227
2.9-4	Noise Levels Measured at Florida Power Corporation Site, Crystal River, October 18, 1977	2-229

CHAPTER 2

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
2.1-1	Site Location	2-2
2.1-2	Topographic Map of Florida Power Corporation, Crystal River Property for Proposed Site	2-3
2.2-1	Site Location (5-Mile Radius)	2-5
2.2-2	Present Land Use (5-Mile Radius)	2-10
2.2-3	Current Zoning (5-Mile Radius)	2-13
2.3-1	Archaeological Site Inventory	2-17
2.4-1	Typical Geologic Column at the Study Site	2-23
2.4-2	Elevation of the Top Rock of the Floridan Aquifer	2-25
2.5-1	Fluctuation of Water Levels in Wells USGS 2, USGS 3, and Lecanto 8	2-33
2.5-2	Location of Wells USGS 1, USGS 2, USGS 3, and Lecanto 8	2-34
2.5-3	Elevation of the Potentiometric Surface of the Upper Floridan Aquifer, May 1975	2-35
2.5-4	Elevation of the Potentiometric Surface of the Upper Floridan Aquifer, September 1975	2-36
2.5-5a	Chloride and Hardness of Water from Well Number 5	2-38
2.5-5b	Sulfate and Conductivity of Water from Well Number 5	2-39
2.5-6	Schematic Cross Section Showing the Dynamic Relationship Between Fresh and Salty Ground Water	2-43
2.5-7	Fluctuation in Chloride Concentrations in Wells USGS 2 and USGS 3	2-45

CHAPTER 2

LIST OF FIGURES
(Continued, page 2 of 3)

<u>Figure</u>		<u>Page</u>
2.5-8	Depth to Base of Potable Water in the Floridan Aquifer	2-46
2.5-9	Average Monthly Rainfall at Inverness, Florida (1899-1975)	2-48
2.5-10	Inflow-Duration Curve for Lake Rousseau	2-53
2.5-11	Schematic Diagram of the Lower-Withlacoochee Cross-Florida Barge Canal Complex	2-55
2.5-12	Profiles of Temperature and Dissolved Oxygen in Lake Rousseau	2-64
2.6-1	Annual Wind Roses for Tampa, Florida, 1971-1975	2-79
2.6-2a	January Through April Wind Roses for Tampa, Florida, 1971-1975	2-80
2.6-2b	May Through August Wind Roses for Tampa, Florida, 1971-1975	2-81
2.6-2c	September Through December Wind Roses for Tampa, Florida, 1971-1975	2-82
2.7-1	Vegetation Map of Proposed Plant Site and Access Corridor	2-96
2.7-2	Vegetation Map of the Vicinity of the Proposed Plant Site	2-97
2.7-3	Conceptualized Plant/Soil/Water Relationships of the Proposed Plant Site	2-146
2.7-4	Similarity of On-Site Plant Communities Based on Species Composition	2-149
2.7-5	Generalized Trend of Plant Succession on Proposed Site	2-151

CHAPTER 2

LIST OF FIGURES (Continued, page 3 of 3)

<u>Figure</u>		<u>Page</u>
2.7-6	Size Distribution of Major Overstory Trees in Three Areas of the Site	2-152
2.7-7	A Typical Food Web-Species Associations Found at the Proposed Plant Site	2-155
2.7-8	Location of Osprey Nests and Aquatic Sampling Sites, 5/22/78	2-182
2.8-1	Ambient Air Monitoring Locations	2-209
2.9-1	Equal Loudness Contours for Pure Tones	2-218
2.9-2	Typical A-Weighted Sound Levels	2-220
2.9-3	Location of Noise Measurement Sites at the Existing Florida Power Corporation Crystal River Plant, October 18, 1977	2-226
2.9-4	Noise Measurements (L_{eq}) as a Function of Distance From Existing Florida Power Corporation Crystal River Facility, October 18, 1977	2-230
2.9-5	Air Concentrations of Salt Drift as a Function of Distance from the Sea	2-233
2.9-6	Natural Drift Deposition Rate as a Function of Distance from the Sea	2-234
2.9-7	Normalized Airborne Salt Values as a Function of the Distance Inland (with an Initial Value of One at Sea Shore)	2-235

2.0

THE SITE

2.1

SITE LOCATION AND LAYOUT

Figure 2.1-1 presents the site of the proposed project relative to the State of Florida, Citrus County, and major municipalities.

The property owned by Florida Power Corporation consists of 1,917 hectares (4,738 acres) located in T17S,R16E, and includes portions of Sections 28-37. The location of the units lies within the southern one half of Section 28 and southeast one quarter of Section 29, Range 16 East, Township 17 South. This location does not include the access road. Approximately 129 hectares (319 acres) are presently occupied by Florida Power Crystal River Units 1, 2, and 3 and support facilities. The use of an additional 136 hectares (335 acres) of the property is proposed for the construction of Crystal River Units 4 and 5, support facilities, and another access road. With the exception of the access road to the existing units, the remaining area is undeveloped.

Figure 2.1-2 shows the proposed site on a topographical map of the area.

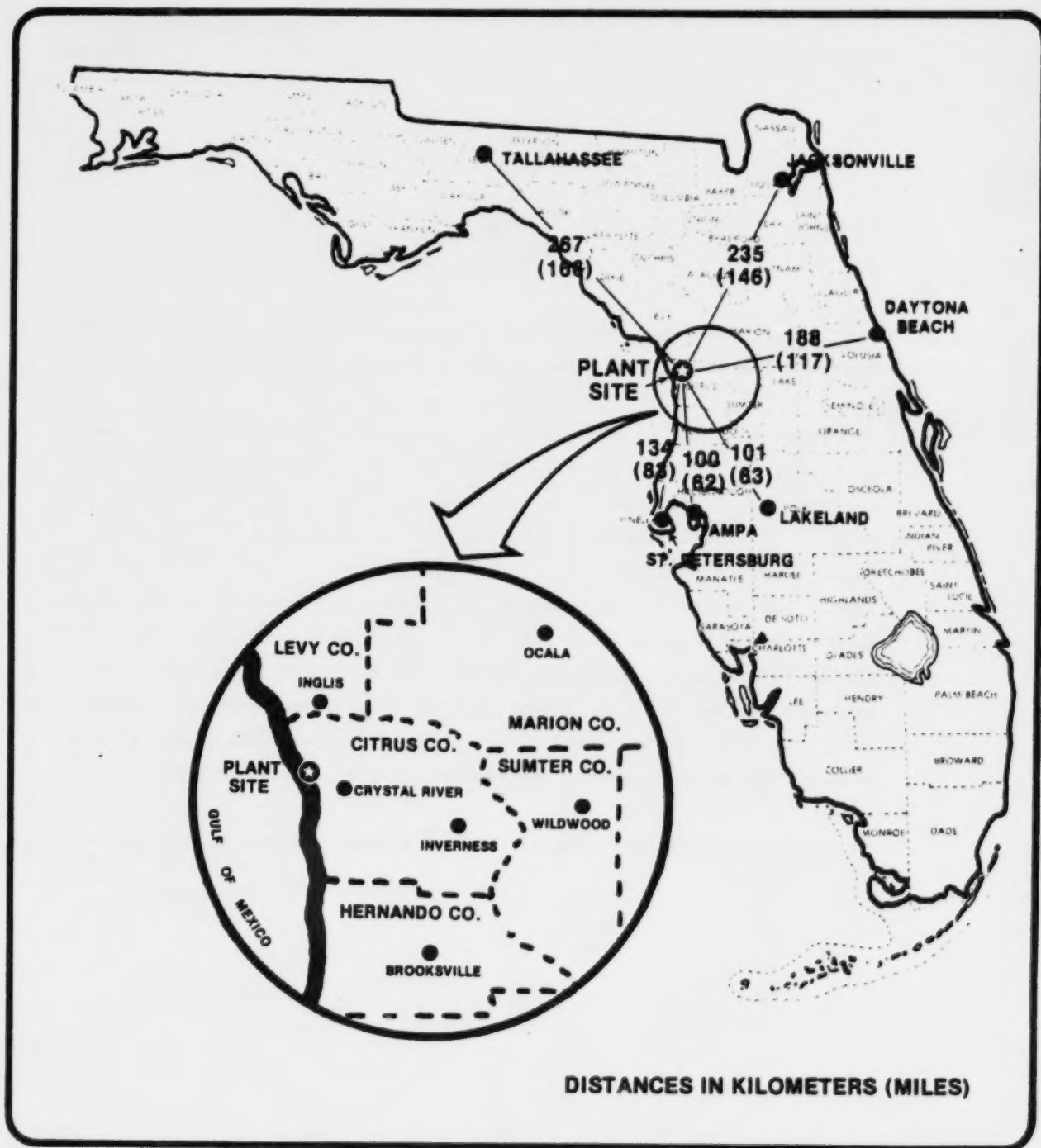


**Figure 2.1-1
SITE LOCATION**

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

**PROPOSED
CRYSTAL RIVER UNITS 4 & 5**

CITRUS COUNTY, FLORIDA

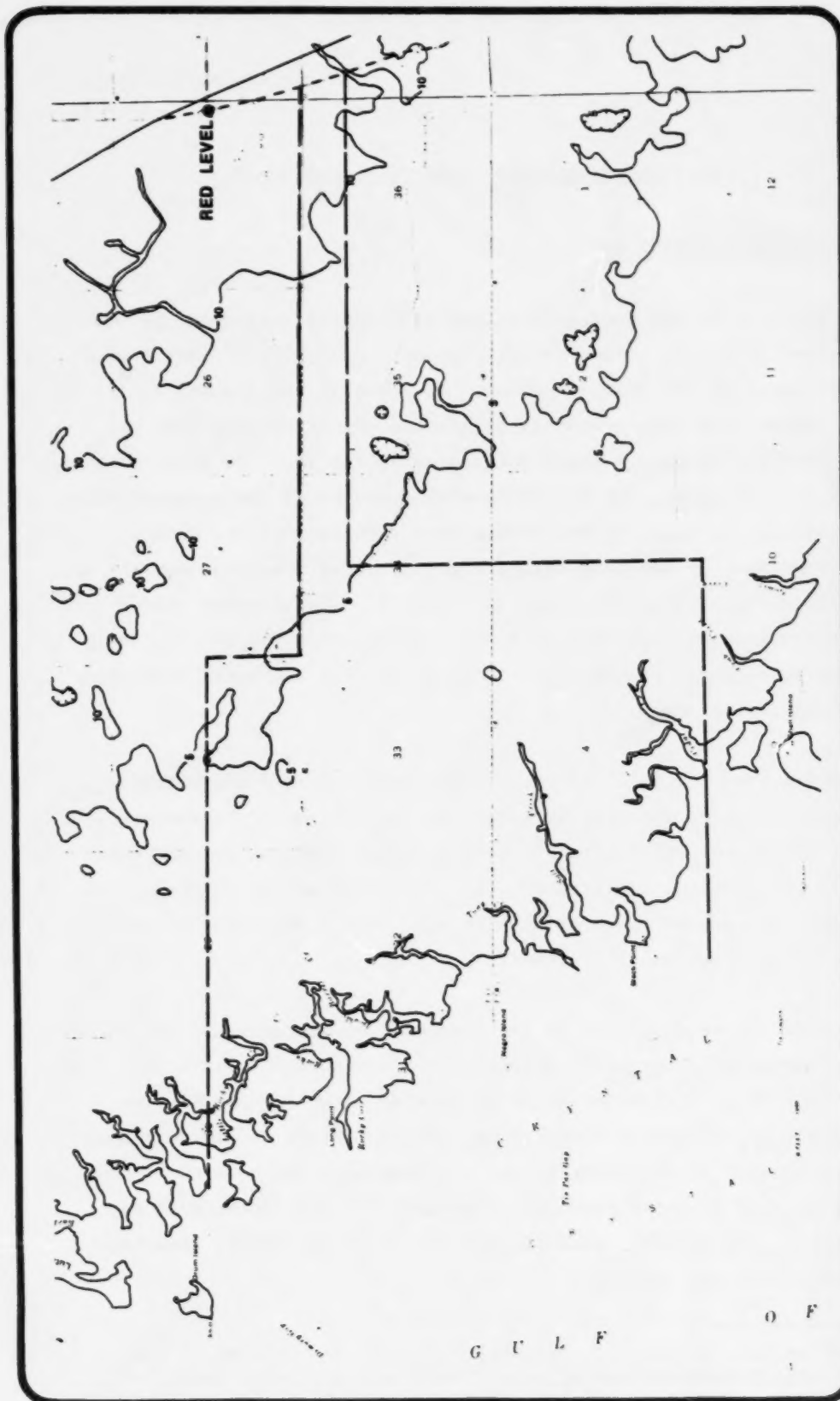
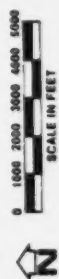


Figure 2.1-2
TOPOGRAPHIC MAP OF FLORIDA POWER CORPORATION, CRYSTAL RIVER
PROPERTY FOR PROPOSED SITE

SOURCE: FROM USGS SURVEY RED LEVEL, FLORIDA 1954



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

2.2 REGIONAL DEMOGRAPHY, LAND, AND WATER USE

2.2.1 FIVE-MILE RADIUS MAP

Figure 2.2-1 shows the 5-mile (8-kilometer)* radius area from the proposed plant site with concentric circles of 1-, 2-, 3-, 4-, and 5-mile radii centered at the stack location. As shown in the figure, the 5-mile radius area lies primarily within the unincorporated area of Citrus County with only a small portion extending into the southern part of Levy County. Also, due to the coastal location of the proposed site, approximately one-third of the 5-mile area extends into the Gulf of Mexico, and much of the land lying to the south of the proposed site is marshland which is unsuitable for development. The property holdings of Florida Power at the proposed site lie wholly within the 5-mile radius area and account for approximately 13.5 percent of the total land area within the radius area.

As shown in Figure 2.2-1, the only incorporated areas lying within 5 miles of the proposed facilities are small portions of Yankeetown and Inglis, which are both located in Levy County. Construction and operation of the proposed facilities will have little effect on these two municipalities due to their small size and lack of any significant supportive services and facilities.

The effects of the construction and operation of the proposed facilities will primarily be centered in Citrus County and particularly in the area of the City of Crystal River which is located approximately 8 miles (13 kilometers) southeast of the site. Crystal River is the only municipality located in proximity to the proposed site which is of sufficient size to offer supportive services and facilities such as food stores, restaurants, gasoline service stations, retail shopping establishments, and housing.

For Section 2.2, in order to be consistent with the wording of Florida regulations, numbers referring to distances are expressed in English measurements with the metric equivalents in parentheses.

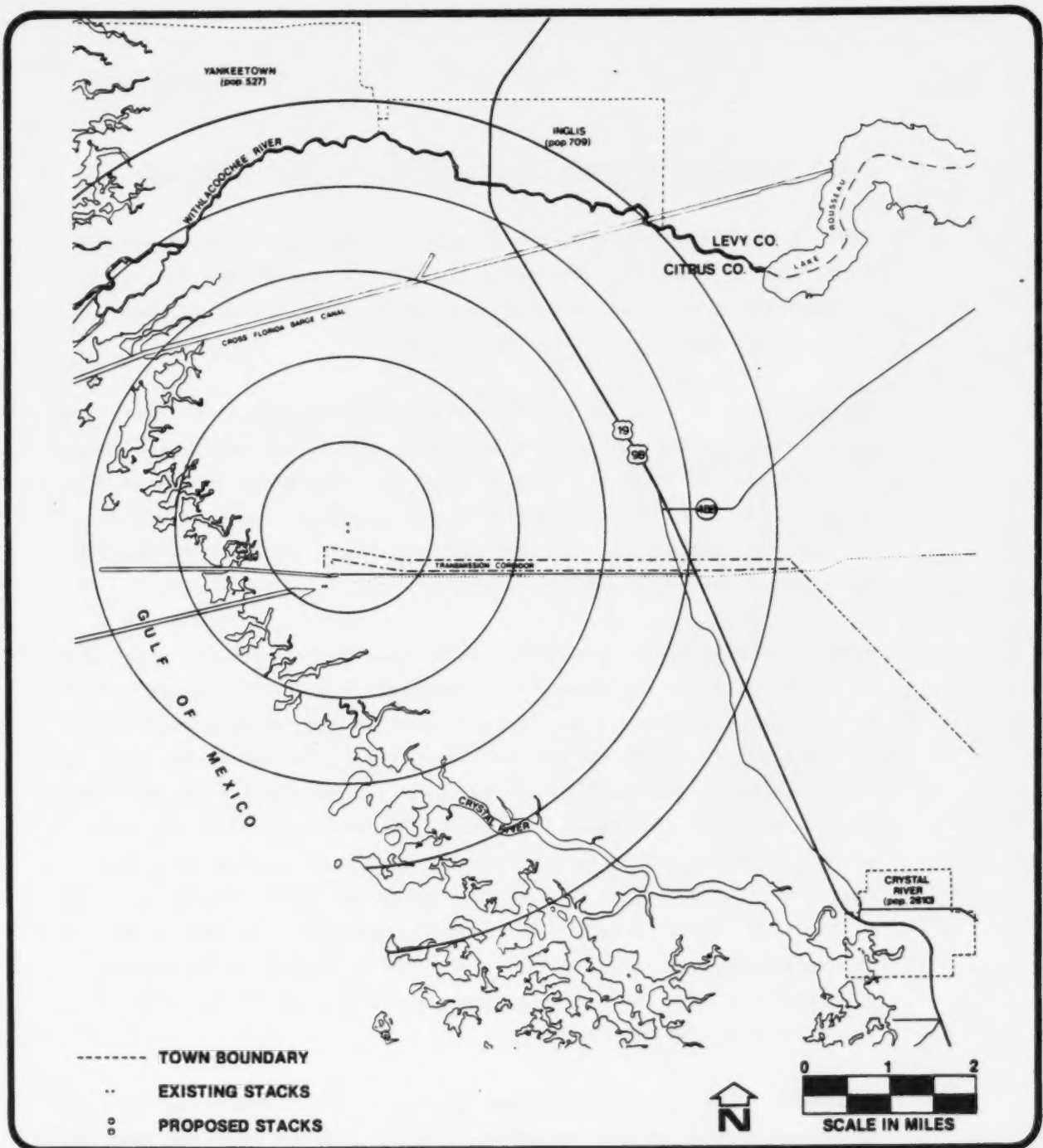


Figure 2.2-1
SITE LOCATION (5 MILE RADIUS)

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

2.2.2 POPULATION OF CITRUS COUNTY AND THE FIVE-MILE RADIUS AREA

Table 2.2-1 lists the populations of Citrus and Levy counties and their incorporated areas as of the April 1, 1970, census and the July 1, 1977, estimates from the Division of Population Studies, Bureau of Economic and Business Research, University of Florida.

Citrus County is located in the northern portion of Florida's West Coast growth corridor and has been experiencing substantial population growth over the past 27 years. During this period, population growth in this corridor has pushed northward from the metropolitan areas of Hillsborough and Pinellas counties through both Pasco and Hernando counties into Citrus County (see Figure 2.1-1).

From 1960 to 1970, the population in Citrus County increased from 9,268 to 19,196 persons, representing an increase of over 107 percent. This growth rate was almost three times faster than the state's overall increase of 37 percent during the same decade. The county has only two incorporated areas, the City of Crystal River and the City of Inverness. Crystal River is located in the coastal lowlands area of the county along the headwaters of Crystal River. Inverness is located in the east-central interior portion of the county and is the county seat. As of the 1970 census, Crystal River had a population of 1,696 persons and Inverness contained 2,299 persons, with the remaining 15,201 persons (79 percent of the total county population) residing in the unincorporated areas of the county.

Since 1970, the rate of population growth in Citrus County has been over three and one-half times that of the state. Citrus County has been the fastest growing county in the state in terms of percentage population change. Between April 1, 1970, and July 1, 1976, the population of the county increased by 101 percent, representing an average annual growth of 13.9 percent compared to the overall state average of 3.9 percent. As of July 1, 1977, the total resident population of Citrus County was estimated to be 38,591 persons, while the City of Crystal River contained 2,635 residents and the City of Inverness had 3,190 residents.

Table 2.2-1. Population of Citrus and Levy Counties, their Municipalities, and Florida, April 1, 1970 Census and July 1, 1977 Estimates

	April 1, 1970 (census)	July 1, 1977 (estimate)	<u>Total Change 1970-1977</u>	
			Number	Percent
FLORIDA	6,791,418	8,717,334	1,926,103	28.4
CITRUS	19,196	38,591	19,395	101.0
Crystal River	1,696	2,635	939	55.4
Inverness	2,299	3,190	891	38.8
Unincorporated	15,201	32,766	17,565	115.6
LEVY	12,756	15,930	3,174	24.9
Bronson	698	822	124	17.8
Cedar Key	714	901	187	26.2
Chiefland	1,965	2,036	71	3.6
Inglis	449	729	280	62.4
Otter Creek	230	187	-43	-18.7
Suwannee River (Levy County part)	35	43	8	22.9
Williston	1,939	2,049	110	5.7
Yankeetown	490	539	49	10.0
Unincorporated	6,236	8,624	2,388	38.3

*The five-mile radius area includes portions of these municipalities and unincorporated areas.

Source: Florida Estimates of Population--Municipalities-Counties-State--July 1, 1977, Division of Population Studies, Bureau of Economic and Business Research, University of Florida, February, 1978.

6/8/80

Therefore, over the past seven years, the majority of population growth in the county has occurred in its unincorporated areas.

According to projections published by the Division of Population Studies, Bureau of Economic of Business Research, University of Florida, in Population Studies, Bulletin No. 41, July, 1977, the population of Citrus County is expected to continue to increase substantially in the future, but at a slightly slower rate than it has since 1970. These projections indicate that the county's population will reach 47,400 persons by the year 1980, 71,000 persons by the year 1990, and 82,200 persons by the year 2000.

As stated earlier, the 5-mile (8-kilometer) radius area surrounding the proposed facilities site is primarily comprised of the unincorporated area of Citrus County with a small part of the area extending into Yankeetown and Inglis in Levy County. The area currently is sparsely populated with small farms, a few clusters of mobile homes, and some single-family residences along the Withlacoochee River in the extreme northern fringe of the area.

Based on a housing unit survey conducted in the area, no people were living within the 3-mile (4.8-kilometer) radius of the proposed site. Also, assuming an average of 2.5 persons per housing unit, it is estimated that approximately 500 persons presently reside within the 3- to 5-mile (4.8- to 8-kilometer) radii from the proposed stack locations.

2.2.3 PRESENT AND PROJECTED LAND USE

Present land use within a 3-mile (4.8-kilometer) radius of the site is limited primarily to agriculture, most of which is pine plantation, the existing Florida Power generation units and related facilities, and the Cross Florida Barge Canal (see Figure 2.2-2). Approximately 2,190 hectares (5,400 acres) are devoted to agriculture, 1,930 hectares (4,760 acres) in pine plantation, and 180 hectares (440 acres) in small farms and improved pasture. The existing Florida Power facilities occupy approximately 129 hectares (319 acres), the Cross Florida Barge Canal approximately 110 hectares (280 acres), with the rest of the land remaining undeveloped.

Between the 3- and 4-mile radii, present land use consists of 390 hectares (970 acres) of agriculture, 420 hectares (1,030 acres) of industrial land use, 2 hectares (5 acres) of commercial development, and about 8 hectares (20 acres) of residential use. Portions of Yankeetown and Inglis lie within the 4- and 5-mile radius (6.4 and 8 kilometer), as well as small scattered areas of agricultural, industrial, commercial and residential land usages. The largest concentration of residential uses within 5 miles (8 kilometers) of the proposed stack location is approximately 50 hectares (120 acres) of unincorporated Citrus County and portions of Yankeetown and Inglis along the north and south banks of the Withlacoochee River.

According to the Withlacoochee Regional Planning Council, no major land use changes are expected to occur within the 5-mile (8-kilometer) radius over the next thirty years. The proposed project would convert primarily vacant land to industrial use.

In the future, some commercial development will probably take place along U.S. Highway 19-98, but will be concentrated at the outer perimeter of the 5-mile (8-kilometer) radius near the municipalities of Crystal River and Inglis.

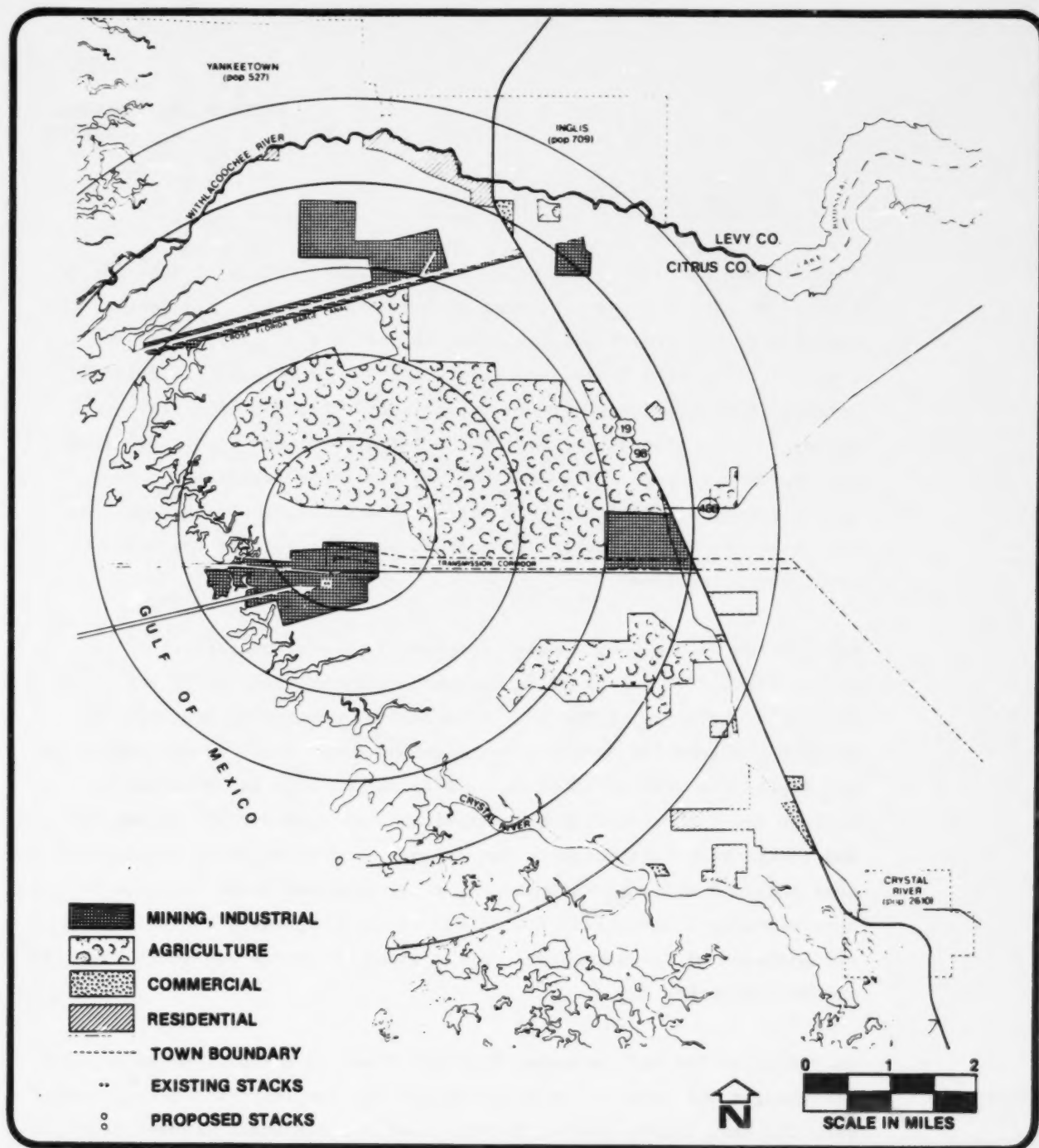


Figure 2.2-2
PRESENT LAND USE (5 MILE RADIUS)

SOURCE: WITHLACOOCHEE REGIONAL PLANNING COUNCIL
ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

FPCR4/5-TSD2.2/R2-2.5
7/1/80

An increase in residential development can also be expected, particularly along the Withlacoochee River from U.S. Highway 19-98 to Lake Rousseau. About 1,940 hectares (4,800 acres) in this area have been subdivided and improved for residential development, but a recent survey revealed only ten homes and no signs of new construction.

2.2.4 ZONING RESTRICTIONS

As shown in Figure 2.2-3, the proposed site is currently zoned for mining and industrial use, as are all lands within its 3-mile (4.8-kilometer) radius, with the exception of approximately 260 hectares (650 acres), which are zoned for agricultural use. An additional 2,020 hectares (4,980 acres) are zoned for mining/industrial use in the 4-mile (6.4-kilometer) radius, along with 460 hectares (1,130 acres) zoned for agriculture, 380 hectares (950 acres) zoned for commercial use, and 780 hectares (1,930 acres) zoned for single-family units and duplex housing. Between the 4- and 5-mile (6.4- to 8-kilometer) radii from the site, approximately 420 hectares (1,560 acres) are zoned for industrial use, 770 hectares (1,900 acres) for agricultural use, 340 hectares (830 acres) for commercial use, 2,520 hectares (6,220 acres) for residential use, and 630 hectares (1,560 acres) occupied by the incorporated areas of Yankeetown and Inglis.

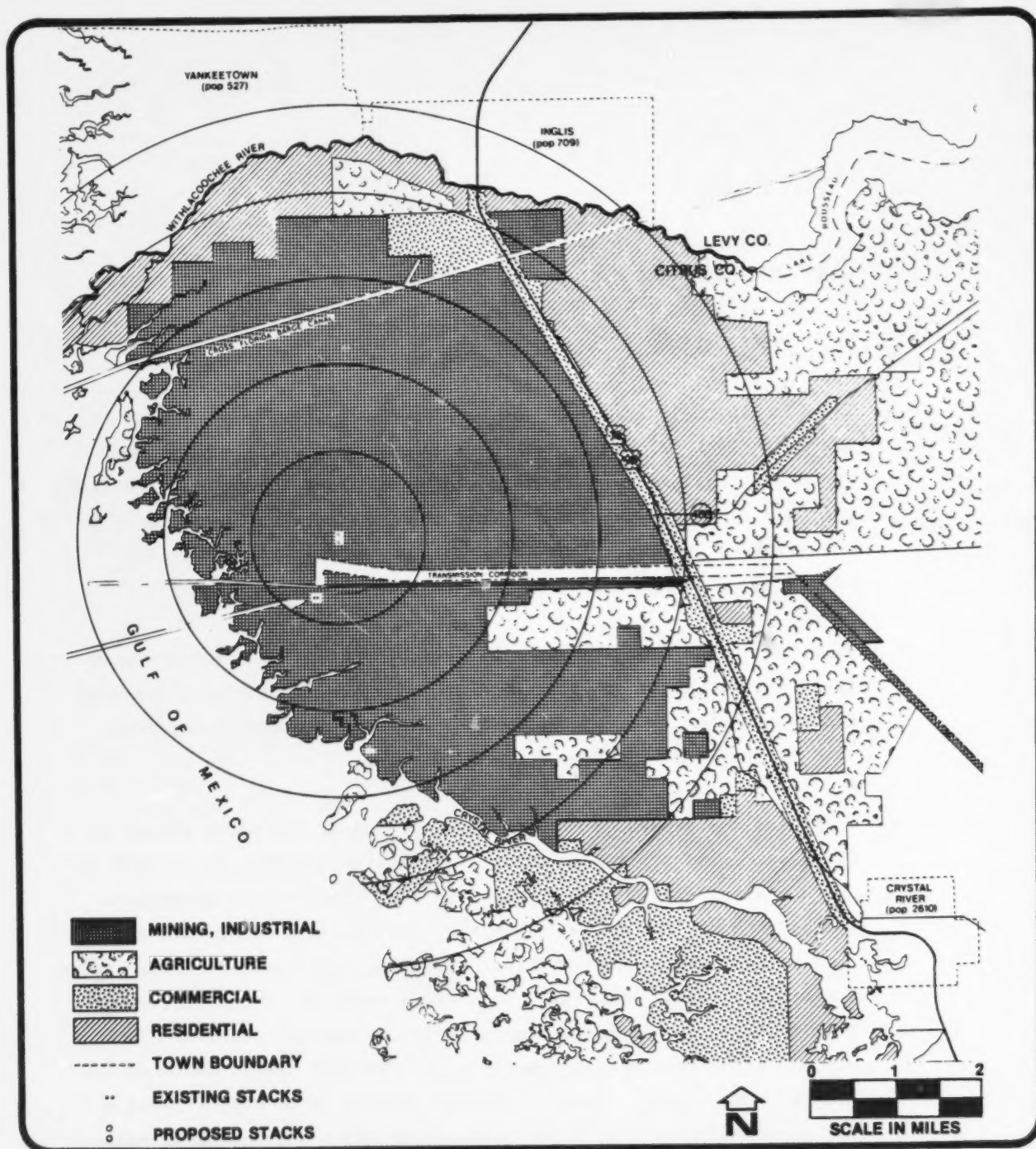


Figure 2.2-3
CURRENT ZONING (5 MILE RADIUS)

SOURCE: CITRUS COUNTY ZONING MAPS, SURVEYORS ASSOCIATES,
REVISED, 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

2.3 REGIONAL HISTORIC, SCENIC, CULTURAL, AND NATURAL LANDMARKS

2.3.1 HISTORY

The stretch of land between the north bank of the Crystal River and the south bank of the Withlacoochee River has a well-authenticated history. Shell mounds and artifacts found along both rivers and along the Gulf of Mexico coastline attest that the area was inhabited by the Timucuan Indians. They farmed small crops in the summer and camped along the rivers in the winter.

Written records indicate that the army of Panfilo de Narvaez encountered the Timucuan in 1528 while he was exploring the area for gold. Finding neither gold nor harborage, Narvaez returned to the coast near St. Marks in the Florida Panhandle.

Following the departure of Narvaez, a period of 300 years passed in which there was no written record of white exploration of the Withlacoochee River area. During this time the United States government issued a decree that would force the Creek Indians of Georgia and Alabama to move west of the Mississippi. Reluctant to leave their native areas, small bands of Creeks, who became known as Seminoles, broke away from the main tribe and moved south to central Florida. They hunted in the Annuttiliga Hammock along the Gulf coast, south of the Withlacoochee River. As the Timucuan before them, they settled along the coast and the river banks through the winter months where ample food was available, and lived peacefully until the white man entered the Indian occupied lands in the early 1830's. The year 1835 marked the beginning of the Seminole War. By 1843, the Indians were either shipped west by the government or had moved further south to the Everglades. By 1844, the area was surveyed and under white occupation.

During the Indian wars, a farming settlement known as Red Level flourished along the present U.S. Highway 19-98. The small rural community still exists today, though there is little reminder of the original settlement save the old cemetery.

The prize stands of red cedar found in the hammocks along the coast were the main attraction for white settlement in the Withlacoochee region. Between 1855 and 1890, large tracts of land were purchased for the timber, which was cut, hauled to the river by oxen, and shipped to the pencil factories in Cedar Key and Crystal River. In the early 1870's, the Chambers sawmill, located on the large island at the mouth of the Withlacoochee River was, at that time, the largest sawmill operating on the west coast of Florida.

By 1890, the phosphate industry became active in the area. The Standard and Hernando Railroad Company was formed to transport phosphate rock from the mines to a point on the Withlacoochee River which is the present site of the Town of Inglis. Port Inglis was established when the Port Inglis Terminal Company set up facilities on Chambers Island at the mouth of the river. The town flourished until World War I halted import of products from Europe. Without the pyrite from which sulphur was obtained, phosphate manufacturing in the area ceased. The railroad was abandoned and the last evidence of the phosphate operation disappeared when, in 1926, Florida Power constructed the Inglis electrical generating facility on the site of the old dryer plant.

2.3.2 ARCHAEOLOGICAL AND HISTORICAL SITES

There are twenty known archaeological sites on the Florida Power Corporation Crystal River property, all of which are recorded in the archaeological site files of the Florida Division of Archives. Eighteen of the sites were recorded as the result of an archaeological and historical inventory of the Crystal River plant property conducted by the Division of Archives, History, and Records Management, Bureau of Historic Sites and Properties for Florida Power in May, 1972. The remaining two sites had been previously recorded. All sites on the plant property are shell middens ranging from possibly as early as 2000 BC to approximately 1000 AD, and occur along the coastline and river banks of the northwestern and southwestern portions of the property (see Figure 2.3-1).

There are no known historical or cultural sites on the property.

Of the 20 archaeological sites on the Florida Power property, only four would possibly be impacted by the construction of the proposed facilities, depending upon final selection of plant location and layout (see Chapter 9.0 for a discussion of plant location and layout alternatives).

THE PLANT SITE ALTERNATIVES

Of the four archaeological sites which would possibly be impacted, one site (8Cil05), is badly deteriorated to a state where it is no longer likely to yield any meaningful data (Hutto and Steinen, 1972), and no cultural artifacts were retrieved. Sites 8Cil08 and 109 are both very small, undisturbed middens but yielded no cultural artifacts in the survey. Site 8Cil10 yielded only one artifact.

Plant Location Alternative 1 would destroy three sites, 8Cil08, 109, and 110 with the construction of the plant run-off pond. Plant Location Alternative 2 would also disturb three sites. The construction

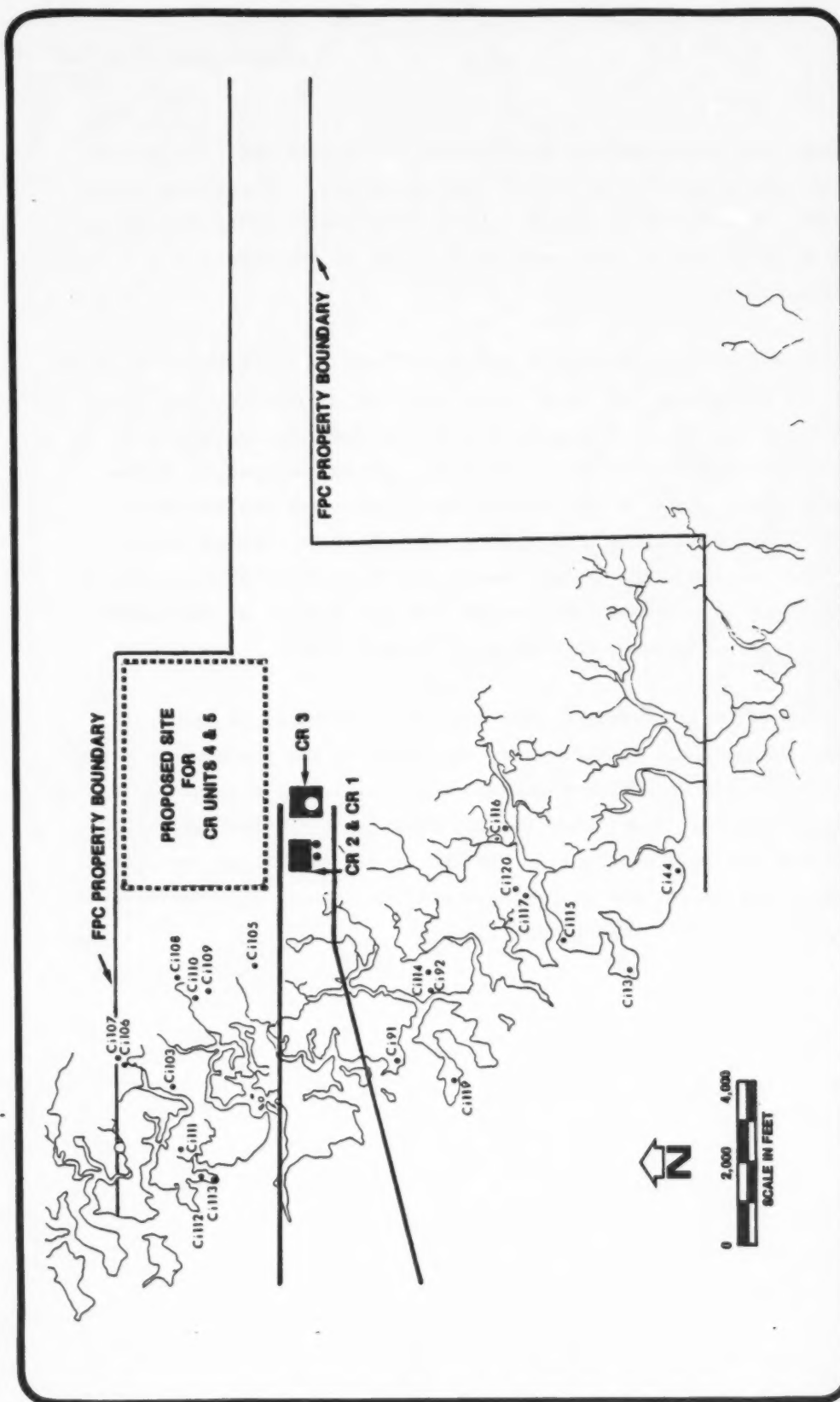


Figure 2.3-1
ARCHAEOLOGICAL SITE INVENTORY

SOURCE: DIVISION OF ARCHIVES, HISTORY, AND RECORDS MANAGEMENT, 1972

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

storage area would include the locations of 8Cil09 and 110, and the 500 KV substation tie would pass through 8Cil05. It has been noted, however, that 8Cil05 is already badly deteriorated, thus the impact upon it would not be considered as great as it would upon an undisturbed site.

Plant Location Alternatives 1c and 3 are both in areas where there are no known archaeological sites since they are located farther inland than 1 and 2. As was discussed earlier in this section and is graphically represented in Figure 2.3-1, Indian occupation on the Florida Power property was focused along the coastline and river banks. The probability of encountering additional unknown sites decreases as one moves inland; hence, Plant Location Alternatives 1c and 3 would be more desirable sites than the others, as they would minimize the chances of encountering unknown sites.

Alternative 1c is preferred over 3 based upon impact on areas of scenic and cultural significance. Location of the plant at 1c would displace no coastal marshes and would minimize displacement of coastal wetland forests. Plant Location Alternative 1c has been selected by Florida Power as the proposed location of the generating facilities. The construction of the proposed facilities at this location will have no impact on known archaeological sites.

2.3.3 SCENIC AND NATURAL LANDMARKS

The area of scenic and natural significance is along the western boundary of the property--the Gulf coastline and the coastal marsh and forested wetlands which make up the system. The significance of the wetland system and the impacts upon it are discussed in Sections 2.5 and 2.7.

2.4

GEOLOGY

2.4.1 SITE DESCRIPTION

The proposed Florida Power plant site is located just north of two existing Florida Power power plants in Citrus County in the area between the Withlacoochee River to the north and the Crystal River to the south. The site is approximately 1.6 kilometers (1 mile) inland from the Gulf of Mexico.

2.4.2 PHYSIOGRAPHY

The geomorphology in this area is defined by two well-developed coastal marine terraces which parallel the coast and mark the landward extent of two Pleistocene seas, the Pamlico and Wicomico, with shorelines at 7.6 meters (25 feet) and 30 meters (100 feet) above mean sea level, respectively. The site is located within the Pamlico marine plain.

The Pamlico is the lowest of the coastal terraces, extending inland from the coast to approximately the 7.6-meter (25-foot) contour which marks the base of a 3- to 6-meter (10- to 20-foot) escarpment. At the site, the plain is approximately 13 to 16 kilometers (8 to 10 miles) wide.

The present coast of Citrus County is submerged, as evidenced by the extensive coastal marshes. According to Vernon (1951), this condition indicates a rising sea level that is out of adjustment to the land mass. As a result, the limestones that underlie the coast are being eroded along coastal margins to form a fairly continuous limestone escarpment 1 to 1.5 meters (3 to 5 feet) above mean sea level. This escarpment passes through the proposed site from the northwest to the southeast. The surface of the proposed site is comprised of a thin veneer of sands overlying a broad limestone shelf. This limestone shelf comprises the top of the Floridan aquifer and is greatly fractured. This fracturing, combined with the discharge from the Floridan aquifer, gives rise to numerous springs scattered throughout the coastal hammock. Most of the streams in the area, such as the Crystal River and the Homosassa River, are spring fed.

As evidenced by the absence of defined stream channels and surface water drainage features, the Pamlico marine plain allows relatively little rainwater runoff in the area of the proposed Florida Power plants.

2.4.3 STRATIGRAPHY

The Floridan aquifer is the upper sequence of rock formations which underlies the study area and contains large volumes of fresh water. The Floridan aquifer is comprised of the Ocala Group, Avon Park Limestone, and the Lake City Limestone. Figure 2.4-1 shows the approximate geologic column at the proposed plant site.

Limestone and dolostone are the primary constituents of the Floridan aquifer. These rocks have recently undergone extensive solution activity during the geologic past when the sea level was much lower. As a result, solution cavities have developed in the upper portion of the aquifer. The most extensive solution zone is believed to have occurred in the Ocala Group and at the contact between the Ocala Group and Avon Park Formation. However, large cavities have been encountered within the Avon Park Formation, and it is believed that large volumes of water flow through this formation (Geraghty and Miller, 1977).

The top of the Floridan aquifer occurs at or near land surface in the coastal zone (Figure 2.4-1) where it is overlain by a thin veneer of surficial deposits composed chiefly of sand. Inland, these surficial deposits increase in thickness. Analysis of data from soil borings drilled in the plant site area, and adjacent transmission corridor indicates that the rock in the coastal zone is directly overlain by deposits composed of sand; however, in the inland areas, a relatively thin sandy layer is present at the base of the surficial deposits which separates the rock from the sand. Table 2.4-1 presents representative soil boring data for the plant site area. The top-of-rock elevation of the Floridan aquifer is shown in Figure 2.4-2 (Geraghty and Miller, 1977).

STRUCTURE

The principal structural features in this area are believed to have formed as a result of the Ocala Uplift. Due to the uplifting, extensive

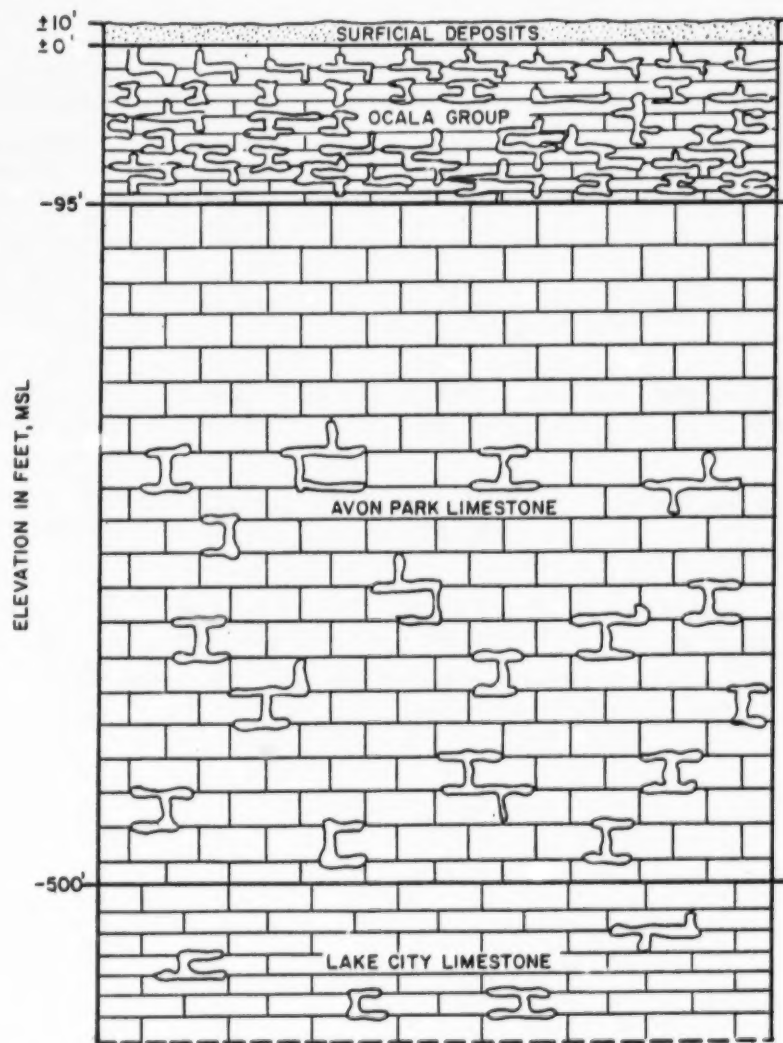


Figure 2.4-1
TYPICAL GEOLOGICAL COLUMN AT THE STUDY SITE

SOURCE: GERAGHTY AND MILLER, INC., 1977



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Table 2.4-1 Plant Site Area Soil Boring

	Mean Meters (feet)	Maximum Meters (feet)	Minimum Meters (feet)
Depth of water table below surface	0.64 (2.1)	1.1 (3.7)	0.37 (1.2)
Upper soil layer thickness	0.85 (2.8)	3.2 (10.5)	0.0 (0.0)
Thickness of Inglis member	14.6 (47.8)	16.2 (53.0)	13.3 (43.7)
Depth to Avon Park formation	15.2 (50.0)	16.9 (55.3)	13.6 (44.7)

Source: Environmental Science and Engineering, Inc., 1978.

fracturing and faulting occurred parallel to the strike of the uplift, as shown in Figure 2.4-2. In addition, differential forces associated with the uplifting also caused minor fractures that developed at right angles to the primary fractures. Therefore, a well-developed fracture system is present throughout the area, with the major axes striking northwest/southeast and the minor axes striking northeast/southwest.

Prior to 1951, faulting was not recognized in Florida; however upon Vernon's publication of Bulletin 33 of the Florida Geological Survey, a well-defined system of high-angle faulting was mapped along the east side of Citrus and Levy counties.

The westernmost extension of the mapped faulting lies 4.8 kilometers (3 miles) east of the plant site. All faulting common to Levy and Citrus counties is oriented along steeply dipping (greater than 60 degree), northwest-trending fault planes which have produced displacements of 6 to 49 meters (20 to 160 feet).

Supplemented by photogeologic studies, subsurface explorations in the form of test borings and a seismic refraction survey eliminate the possibility that faulting exists beneath the proposed plant site because:

1. Correlation of marker horizons delineated by rock cores negates any inference that vertical displacement exists in the subsurface. Marker beds exist at expected elevations in points of investigation (drill holes).
2. Seismic profiles also showed no anomalous changes in elevations of velocity layers.

The nearest faulting occurs at a distance of 4.8 kilometers (3 miles) to the east of the site. Stratigraphic correlation and continuity of seismic refraction profiles negate the possible existence of subsurface faults at the site.

SEISMICITY

Weston Geophysical Research, Inc. conducted the seismic study which involved a thorough literature search and examined available seismograms

to determine the epicentral distribution of earthquakes in the southeastern United States, their focal depth, intensity and/or magnitude, and attenuation characteristics. Regional tectonics and fault patterns were investigated for possible association with known epicenters. This study indicates that the State of Florida is seismically inactive and that the closest area to the site of significant seismic activity is Charleston, South Carolina. Attenuation data available for this area indicate that the site experienced an observed intensity no higher than Intensity V (Modified Mercalli). The maximum ground motion at the site due to this earthquake probably did not exceed 0.025 gram.

The site is located in Seismic Zone 1 (Department of Army, Navy, and Air Force, 1973) which is rated as probable to expect only minor damage. Therefore, the area is considered seismically stable.

2.4.4 SOILS

Soils on and around the site are nearly level and poorly drained. In the eastern portion of the site, the dominant soil association is the Broward-Boca association. These are sandy soils underlain by limestone. While these soils present severe restrictions to development because of wetness and a relatively shallow depth to limerock, they are the most dependable soils on the property. To the west, the soils are extremely wet, classified as either freshwater swamp or saltwater marsh. These soils are subject to frequent and prolonged flooding.

2.4.5 FLOODING

Because of the extreme flatness of the site and the proximity to the Gulf of Mexico, the area is subject to flooding. The most extensive flooding to be expected at the site will be produced by abnormally high tides resulting from hurricane surge and over-riding wind waves. The U.S. Army Corps of Engineers estimates the elevation of the "mean annual flood" (a flood with a 43 percent chance of occurring in any given year) at the mouth of the Withlacoochee River to be 1 meter (3 feet) above mean sea level. The USGS estimates the 100-year flood elevation at the site to be approximately 3.4 meters (11 feet) above mean sea level. Hurricane surge and wind waves at the plant site have been described in detail in "Report-Verification Study of Dames and Moore's Hurricane Storm Surge Model with Application of Crystal River Unit 3 Nuclear Plant--Crystal River, Florida--for Florida Power Corporation" (1973). The maximum storm tide computed by Dames and Moore is 8.96 meters (29.4 feet) above mean low water. This value includes a 0.6-meter (2-foot) reduction due to backwater effects. Maximum tidal setup will occur when hurricane winds blow onshore, tracking normal to offshore bottom contours (southwest to northeast). Assuming wind vectors normal to the coast, the maximum wave height that can traverse the fill bordering Unit 3 is 4.6 meters (15.0 feet).

2.5

HYDROLOGY

2.5.1 GROUND WATER

Most of the area groundwater flow is concentrated in a moderately thin zone just below the water table (Faulkner, 1973). The upper rock of the Avon Park Formation impedes the downward movement of water, causing the preferred flow path of water recharged to the aquifer to be in the horizontal direction in the highly permeable sections of the Ocala Group.

Large quantities of water flow through the groundwater system and break out in the numerous springs in the area. Discharges at Crystal River Springs have averaged 2.24 million cubic meters (592 million gallons) per day (USGS, 1976) during the last 12 years. Although it is not recorded, ground water is also discharged from springs and seeps located along the coast. From a flow-net analysis of the area, Geraghty and Miller (1977) estimate that these additional unrecorded spring discharges between Crystal River and the Cross-Florida Barge Canal could be approximately 9.46 mld (250 mgd).

AQUIFER CHARACTERISTICS

Geraghty and Miller (1977) used an indirect technique to estimate the aquifer transmissivity. A flow-net analysis of the ground water discharging into Crystal River between the 5-foot and 10-foot contours on the potentiometric surface for May, 1977 (Figure 2.5-3) yielded an average transmissivity of about 17,300,000 liters per day per meter (15 million gallons per day per foot). This value is comparable to that found for the Silver Springs area by Faulkner (1973) and is indicative of a very permeable aquifer.

In June 1978 an aquifer test was performed at the proposed well field site by Geraghty and Miller. The aquifer coefficients estimated from a flow net analysis and that obtained as a result of the pumping test are:

	Estimated	Actual
Transmissivity	1.86×10^8 lpd/meter, (1.5×10^7 gpd/foot)	563,700 lpd/meter, (45,390 gpd/foot)
Storage coefficient	0.2-0.0002	0.0003
Leakance	---	(0.028 gpd/foot) 3.74 lpd/cubic meter

The difference in the values obtained by the flow-net analysis and the aquifer test are thought to be the result of local variations in the hydrogeologic system. The flow-net analysis can only give an average figure for transmissivity. Solution channels or highly permeable rock zones may act as conduits which carry the water to discharge areas (such as springs or seeps) along the coast. Areas between the solution channels may exhibit much lower permeability and therefore much lower transmissivities.

No determinations are available of the storage coefficient or leakance in the area. However, because the upper portion of the aquifer near the plant site is under water-table conditions, the storage coefficient is estimated to be on the order of .05 to .20 by Geraghty and Miller. This means that for every unit volume of rock, approximately 5 to 20 percent of that volume is water which can be released from storage under the influence of gravity.

The upper portion of the aquifer is composed of a network of solution features that serve to transmit large quantities of water under natural or man-imposed gradients. The permeability of the deeper portion of the aquifer is not known. The deeper portion of the aquifer may also possess a high transmissivity (Geraghty and Miller, 1977) due to deeper solution channel systems which have developed in the geologic

past. These systems are being indicated by the cavities encountered in two of the four 61-meter (4-foot) deep borings from the nuclear plant site.

WATER-LEVEL CHANGES

The water levels in the Floridan Aquifer fluctuate seasonally. The lowest point generally occurs in May after the dry season and the highest point occurs in September after the wet season. Figure 2.5-1 shows the water-level fluctuations in two USGS (United States Geological Survey) observation wells and in a well located further inland near Lecanto. The locations of these wells are shown in Figure 2.5-2. Note that the water-level fluctuations are greater in the inland areas than along the coast. The fluctuations near the coast are generally less than 1 meter (3 feet), but further inland they may be as much as 1.5 to 2 meters (5 to 6 feet) (Geraghty and Miller, 1977).

Figures 2.5-3 and 2.5-4 show the elevations of the regional potentiometric surfaces of the upper Floridan Aquifer in May and September, 1975, respectively. Ground water moves perpendicular to the lines of equal elevation of the potentiometric surface, from points of higher elevation to points of lower elevation. In the study area, groundwater flow is generally in a southerly to westerly direction.

The wide spacing between the contour lines in the figures discussed above is primarily a result of the high transmissivity of the aquifer. If the aquifer were not so transmissive, larger frictional losses would result and the gradient would be steeper in order to maintain the same amount of flow (Geraghty and Miller, 1977).

In the area at the westernmost tip of Lake Rousseau, the close configuration of the contour lines (i.e., trough in the potentiometric surface paralleling the Cross-Florida Barge Canal) indicates that ground water is discharged into the canal. In September 1975, (Figure 2.5-4) the

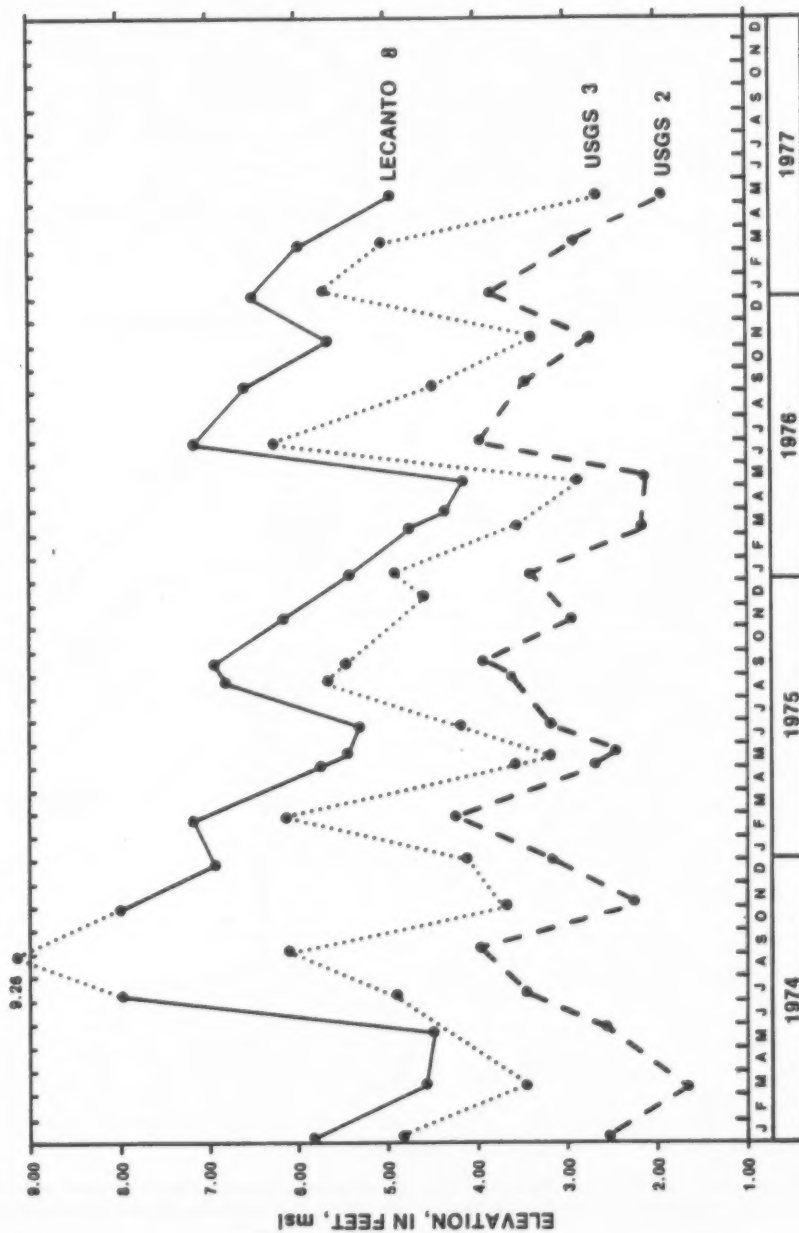


Figure 2.5-1
FLUCTUATION OF WATER LEVELS IN WELLS USGS2, USGS3, AND LECANTO 8

SOURCE: GERAGHTY AND MILLER, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

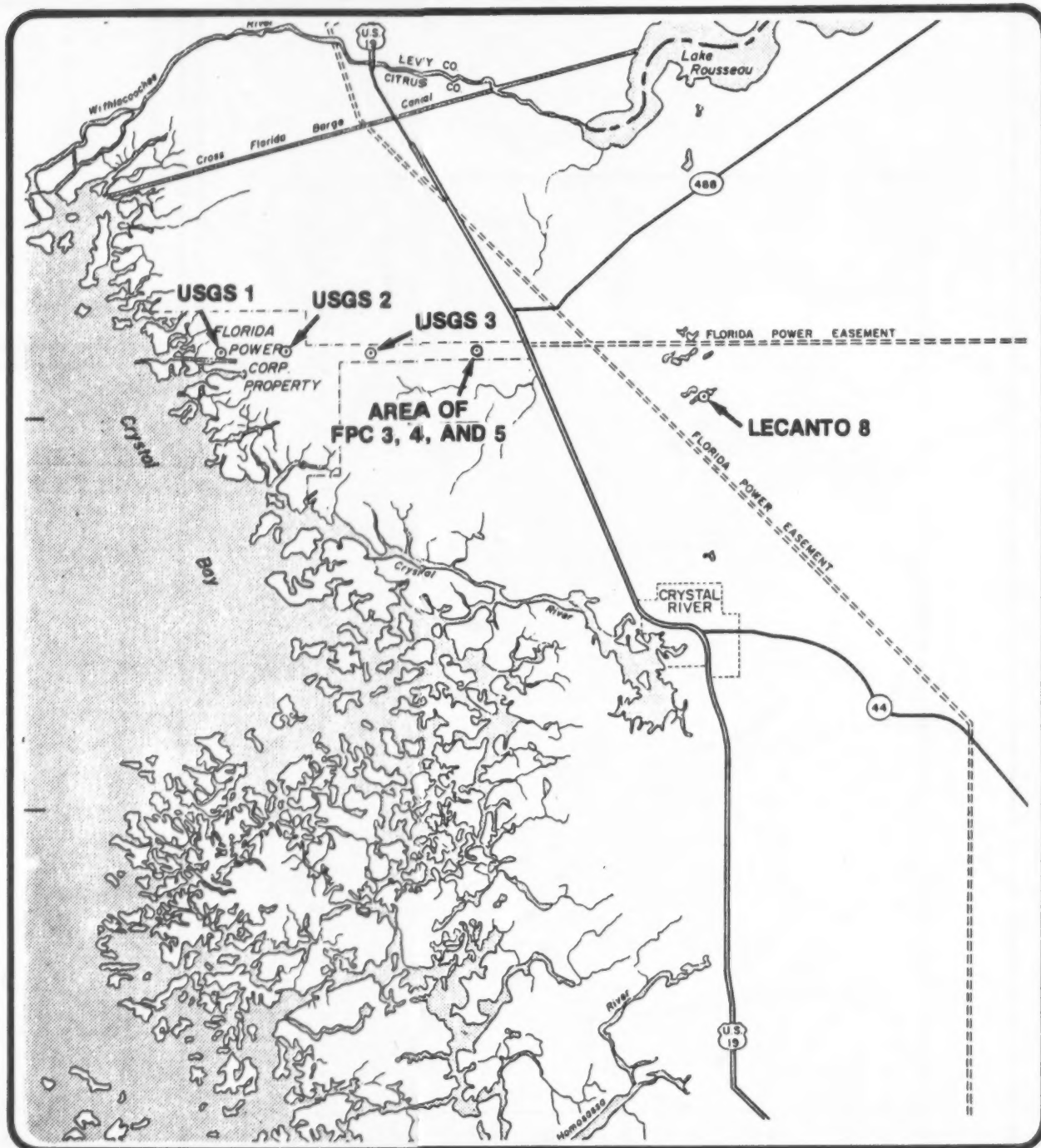


Figure 2.5-2

LOCATION OF WELLS

USGS 1, USGS 2, USGS 3, LECANTO 8, AND FPC 3, 4, AND 5

SOURCE: GERAGHTY AND MILLER, INC., 1977



FLORIDA POWER CORPORATION

**PROPOSED
CRYSTAL RIVER UNITS 4 & 5**

CITRUS COUNTY, FLORIDA

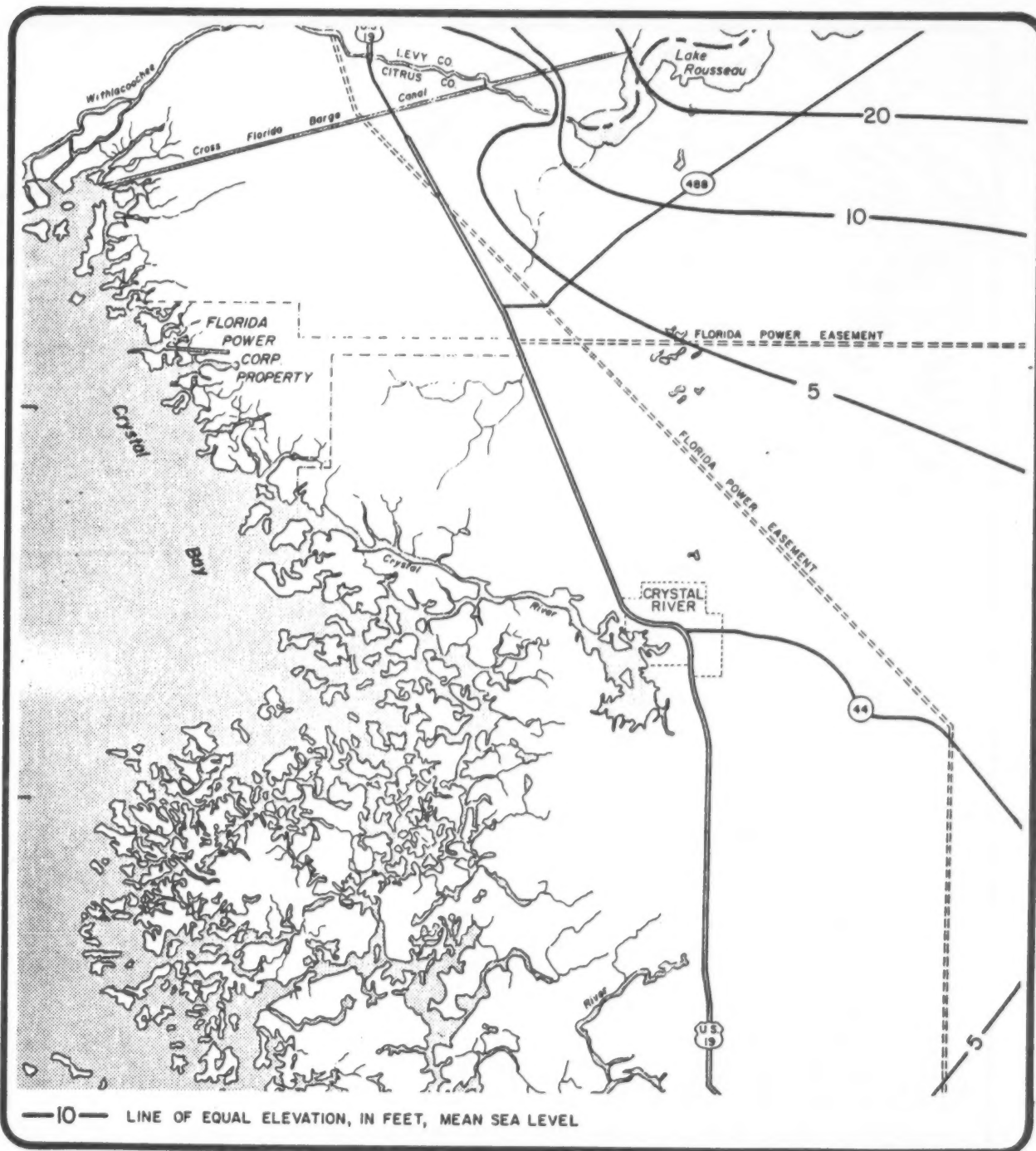


Figure 2.5-3
ELEVATION OF THE POTENTIOMETRIC SURFACE OF
THE UPPER FLORIDAN AQUIFER, MAY, 1975

SOURCE: GERAGHTY AND MILLER, INC., 1977



FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

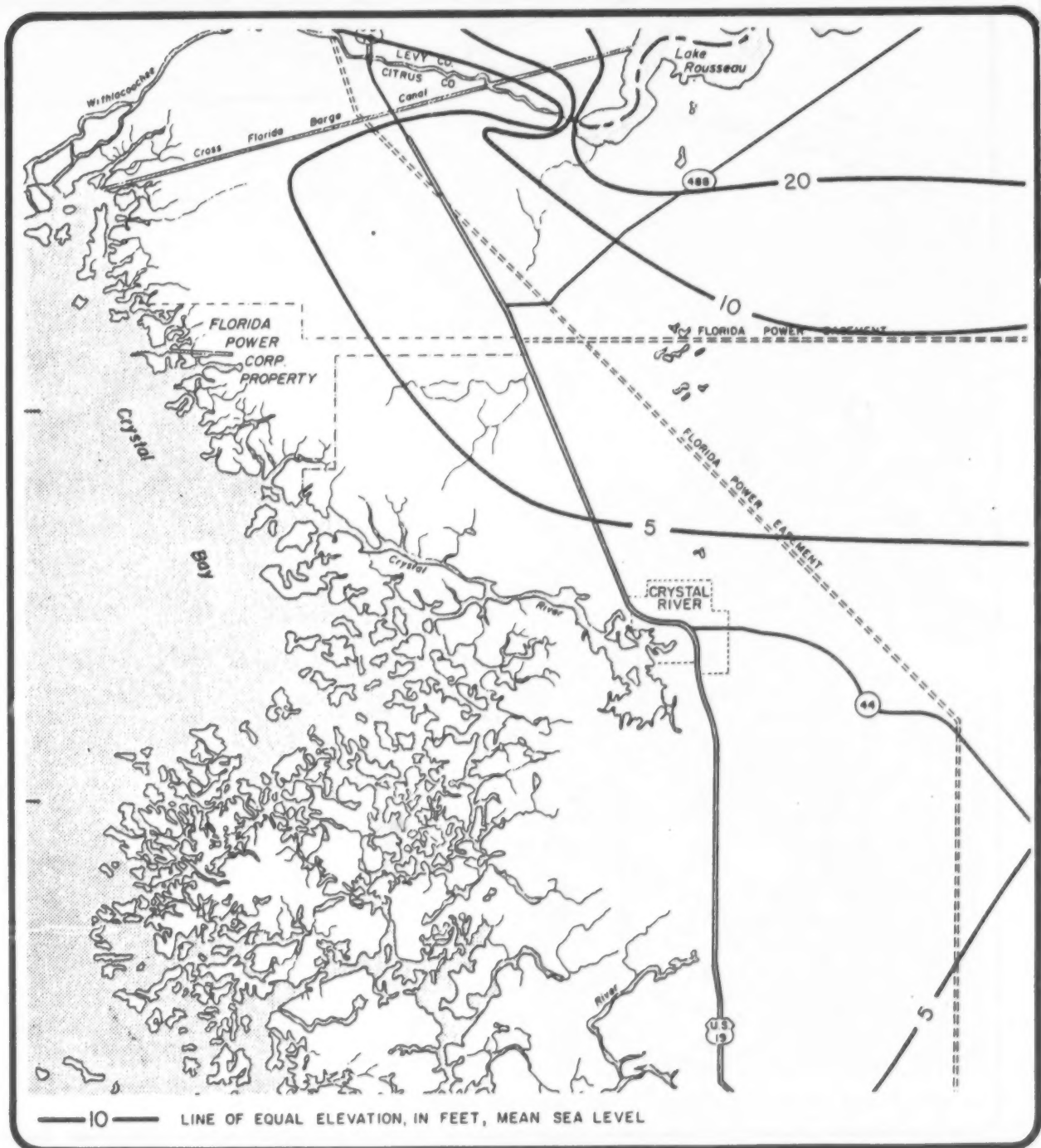


Figure 2.5-4
ELEVATION OF THE POTENTIOMETRIC SURFACE OF
THE UPPER FLORIDAN AQUIFER, SEPTEMBER, 1975

SOURCE: GERAGHTY AND MILLER, INC., 1977



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

trough was much more pronounced than in May, 1975. The discharge to the river was significant in September, but limited in May, 1975, a low-flow period.

WATER QUALITY

Wells used for service water at the existing Florida Power Corporation units have been monitored since 1966 for some conventional water quality parameters. The location of these wells is shown in Figure 2.5-2. The trends in water quality (chloride, sulfate, hardness as CaCO_3 , and conductivity) for well number 5 are shown in Figures 2.5-5a and b. Data from wells number 3 and 4 are similar to that of well number 5. No significant increase in these parameters is noticeable over the period of record.

WATER BUDGET

One method for demonstrating the volumes of water flowing through the groundwater system is to analyze the elements of the water budget. The water budget is based upon the principle of conservation of mass and can be expressed mathematically as:

$$P - ET - R - GR = \Delta S$$

where P is precipitation, ET is evapotranspiration loss, R is surface-water runoff, GR is recharge to the groundwater system, and ΔS is change in storage in the groundwater system. Over long periods of time the average elevation of the potentiometric surface has been more or less the same. As a consequence, the change in storage can be assumed to equal zero. At the proposed wellfield site very little surface runoff occurs; therefore, the value for this term in the water-budget equation is also assumed equal to zero. Thus, the evapotranspiration loss plus the recharge to ground water must equal the precipitation. The long-term precipitation averages about 1,400 millimeters (55 inches) per year and the evapotranspiration losses are assumed to range between

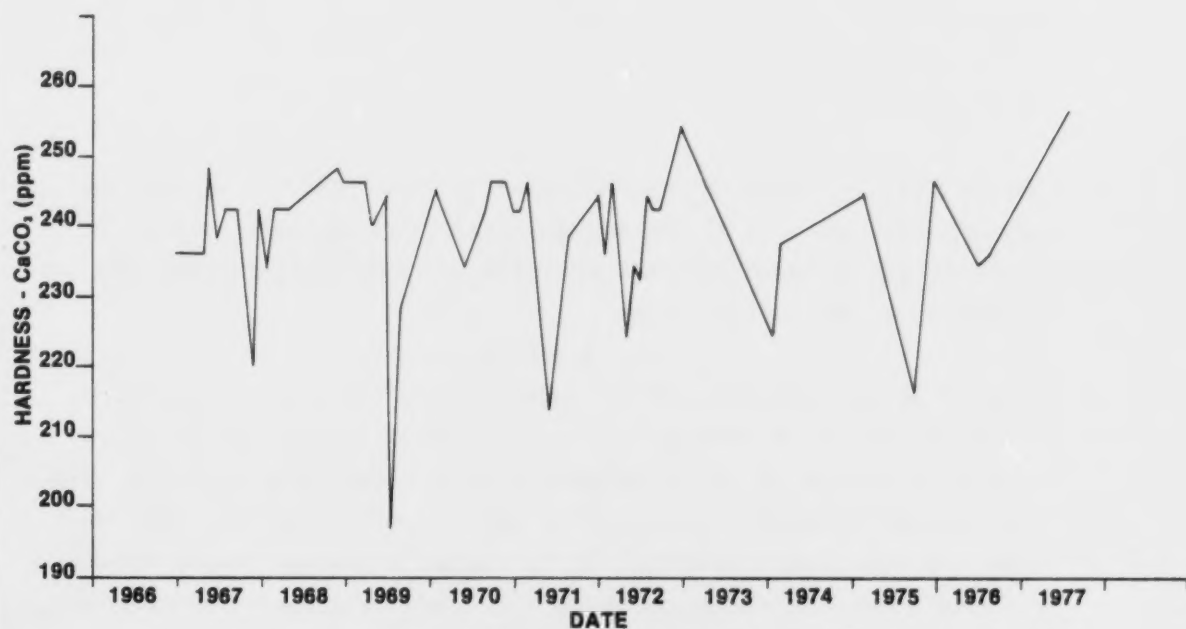


Figure 2.5-5a
CHLORIDE AND HARDNESS OF WATER FROM
WELL NO. 5

SOURCE: FLORIDA POWER CORPORATION, 1978

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

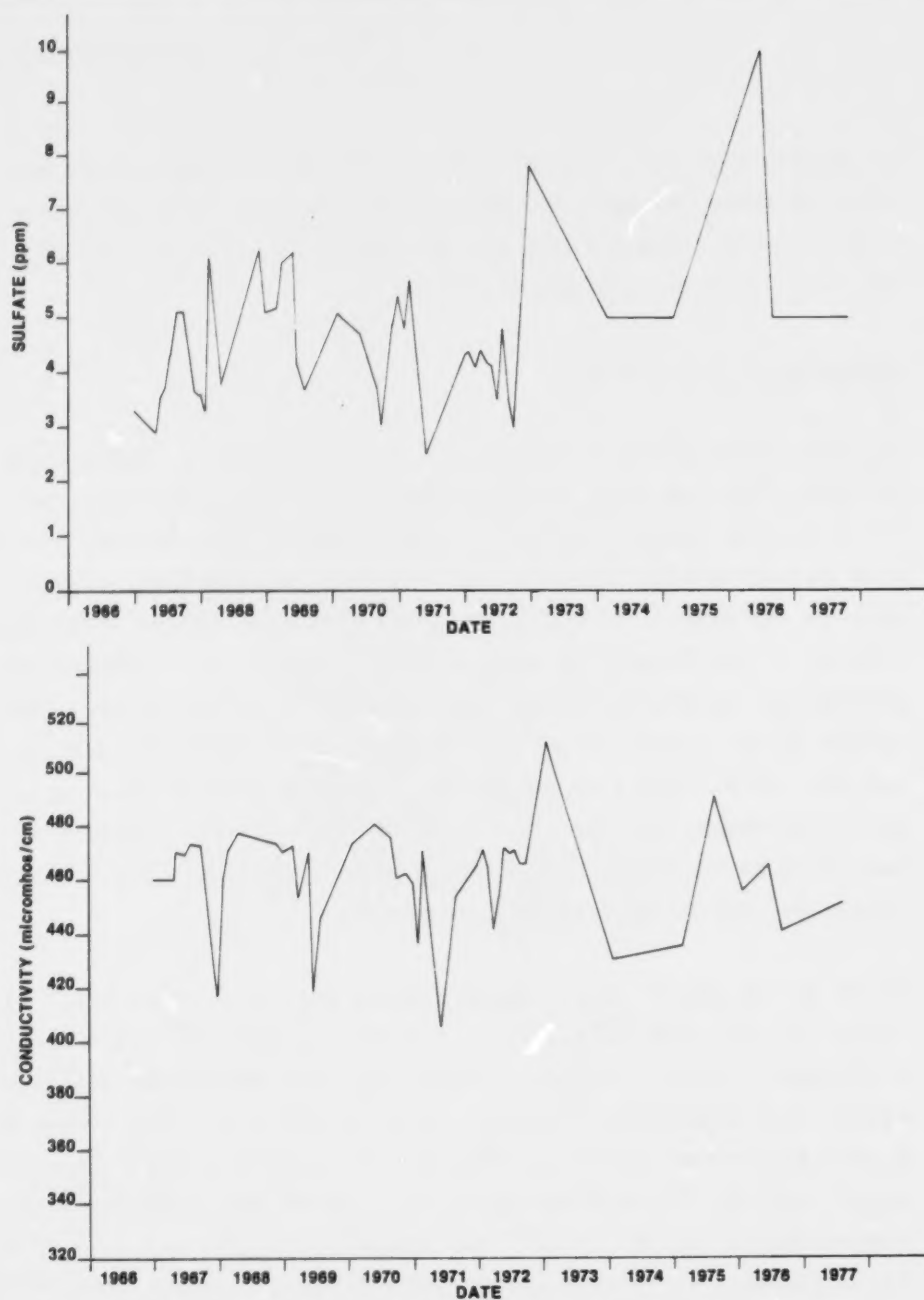


Figure 2.5-5b
SULFATE AND CONDUCTIVITY OF WATER FROM
WELL NO. 5

SOURCE: FLORIDA POWER CORPORATION, 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

760 millimeters and 1,020 millimeters (30 and 40 inches) per year. Based on these assumptions, the rate of recharge to ground water is calculated to range between 380 and 640 millimeters (15 and 25 inches) per year (Geraghty and Miller, 1977).

Groundwater Withdrawals

In 1976, groundwater withdrawals in Citrus County for industrial, agricultural, and municipal purposes totaled 87.8 million liters per day (23.2 million gallons per day). Approximately half of this amount is used for irrigation and only 14.9 million liters per day (3.9 million gallons per day) is used for municipal purposes. There is no concentration of withdrawals in any one area. Table 2.5-1 presents the present and projected future water demands in Citrus County. The total demand in the county by 2035 is expected to be about 197 million liters per day (52 million gallons per day), roughly half of which will be for municipal demand and the other half for agriculture. Industrial demand, excluding power plants, is expected to be approximately 7.6 million liters per day (2 million gallons per day).

There are no public water supply systems within an 8-kilometer (5-mile) radius of the plant site. Three systems lie just outside close to the 8-kilometer (5-mile) radius. These are: the Yankeetown public water system [9.7 kilometers (6 miles) north of the site], the Indian Waters Subdivision water system [9.7 kilometers (6 miles) southeast of the site], and the Thunderbird Mobile Park system [9.7 kilometers (6 miles) east-southeast of the site]. The Yankeetown system consists of three 102-millimeter (4-inch) diameter wells ranging in depth from 16.8 to 21.3 millimeters (55 to 70 feet) and serving 55 connections. Capacities range from 190 to 389 liters (50 to 100 gallons) per minute. The Indian Waters Subdivision system consists of one 152-millimeter (6-inch) diameter well, 34.4 meters (113 feet) deep, providing 757 liters (200 gallons) per minute. The Thunderbird Mobile Park system consists of one 102-millimeter (4-inch) diameter well, 12.2 meters (40 feet)

Table 2.5-1 Present and Projected Future Water Demands in Citrus County
in Millions of Liters Per Day (Millions of Gallons Per Day)

	Water Demand 1975	Projected Water Demand 1985	Projected Water Demand 2035
Municipal	14.8 (3.9)	25.7 (6.8)	87.4 (23.1)
Industrial*	31.0 (8.2)	29.1 (7.7)	7.6 (2.0)
Agricultural	42.0 (11.1)	45.4 (12.0)	101.1 (26.7)
Totals	87.8 (23.2)	100.3 (26.5)	196.1 (51.8)

*Excludes power plant demands.

Source: Water Resources Management Study, Hydrologic and Engineering
Evaluation of the Four River Basins Area, West Central Florida,
1977.

deep, providing 151 liters per minute (40 gallons per minute) and serving 54 connections.

SALTWATER INTERFACE

Due to the density differences between fresh water and salt water, salt water supports a wedge of fresh water near the coast. This freshwater zone is thinnest at the coast and is thickest inland. The transitional zone between the salt water and the fresh water contains brackish water with a chloride content ranging between 250 and 19,000 milligrams per liter (mg/l). The thickness of this transitional zone varies spatially. Since the salt/freshwater interface is under dynamic conditions, as illustrated in Figure 2.5-6, it moves under natural and man-induced stresses in the system (Geraghty and Miller, 1977).

The construction of Florida Power Corporation's receiving canal in 1966 is an example of a man-induced stress on the hydrologic system. The canal was dug perpendicular to the coast for several thousand feet to a depth of approximately 4.26 meters (14 feet) below mean sea level. This provided a short circuit (and drain) for the groundwater system, causing flow from the aquifer to the canal. The water levels in the aquifer declined. This lowering caused the interface to establish a new equilibrium further inland.

The interface movement resulting from the construction of the canal is demonstrated by an increase in chloride concentrations from water sampled in well USGS 1. This well was drilled in 1965 to a depth of 21.3 meters (70 feet) and cased to 18.3 meters (60 feet). The initial chloride content of the water from the well was 1,740 mg/l. In 1971, after canal construction, the chloride had risen to over 5,000 mg/l. Studies conducted by Faulkner (1972) indicate that similar conditions occurred north of the plant site after construction of the Cross-Florida Barge Canal.

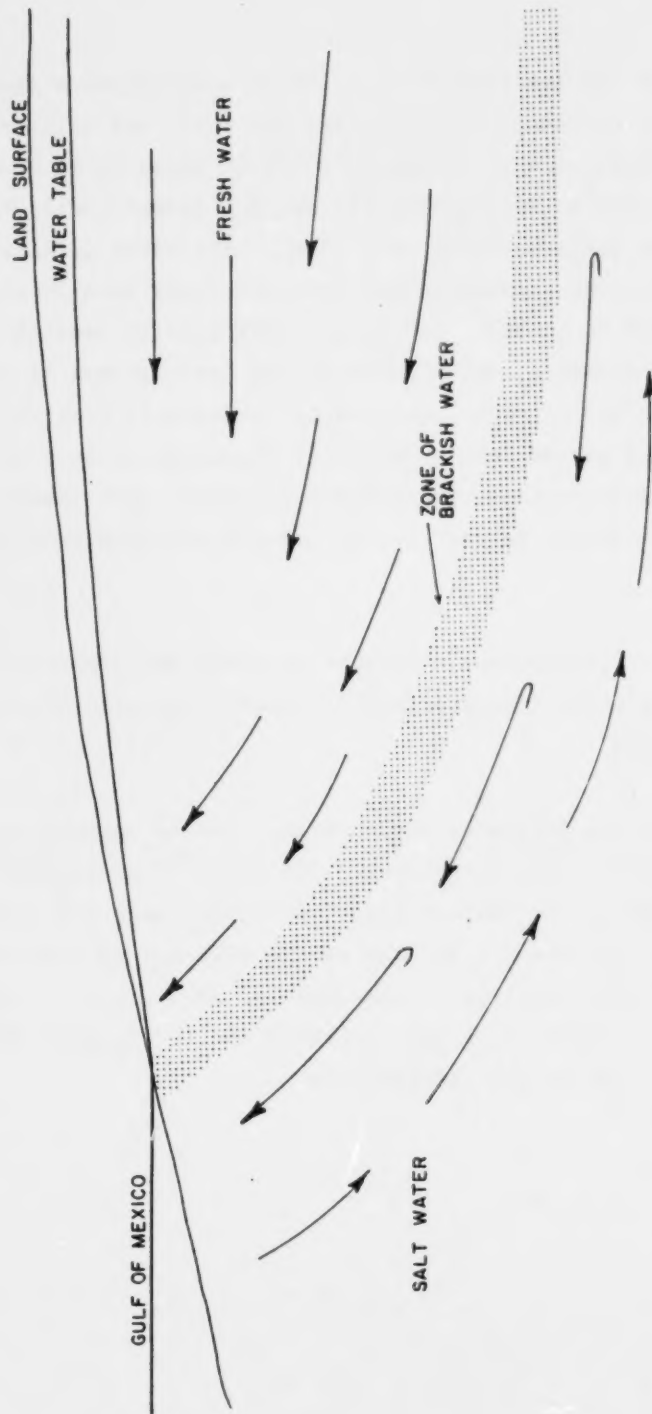


Figure 2.5-8
SCHEMATIC CROSS SECTION SHOWING THE DYNAMIC RELATIONSHIP BETWEEN
FRESH AND SALTY GROUND WATER

SOURCE: GERAGHTY AND MILLER, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 2.5-7 shows the fluctuation in chloride concentration recorded in well USGS 2, which is cased to 20.4 meters (67 feet) and drilled to 26.8 meters (88 feet), and well USGS 3, which is cased to 12.8 meters (42 feet) and drilled to 14.3 meters (47 feet). Because well USGS 3 is further inland and shallower than well USGS 2, its water quality is better and its chloride concentrations have generally been less than 20 mg/l. Well USGS 2, on the other hand, appears to be located in the proximity of the interface, which occasionally moves inland of this well. An increase in chloride concentration is usually observed in this well during the dry season when groundwater discharge is at a minimum. When the rainy season arrives, increased groundwater flow towards the Gulf pushes the interface seaward again, and the chloride concentration is reduced.

Geraghty and Miller (1977) concluded that no trend was apparent in the chloride data that would indicate that saltwater intrusion is occurring on a permanent basis.

Figure 2.5-8 shows the estimated depth to the base of potable water in the Floridan aquifer in the study area. The position of the 250-mg/l isochlor at a depth of 30.5 meters (100 feet) below mean sea level was determined from wells recently drilled by the USGS and is considered reliable. However, the position of the isochlor at depths of 76 to 152 meters (250 to 500 feet) is less reliable due to the wide scatter of the control wells used in the determinations.

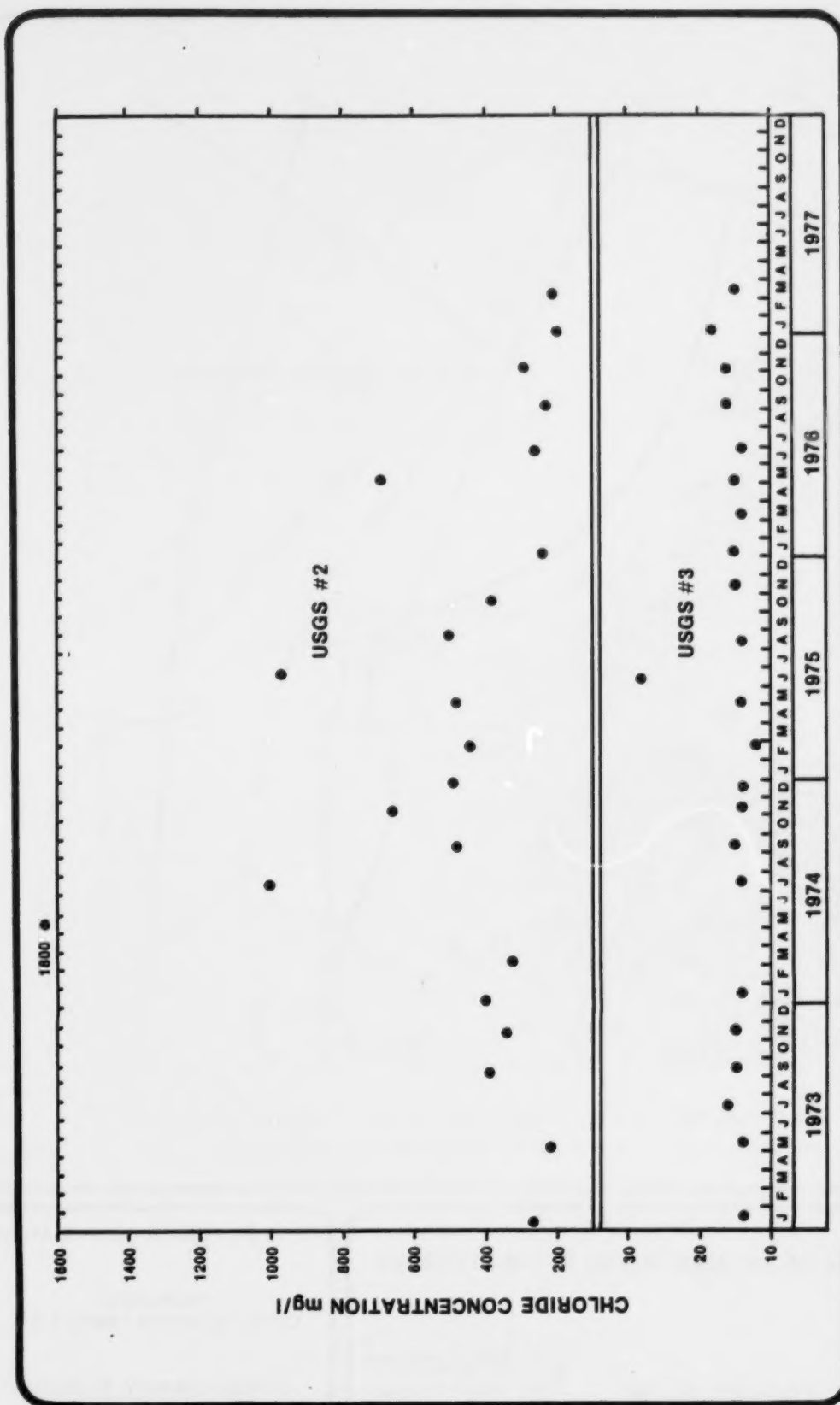


Figure 2.5-7
FLUCTUATION IN CHLORIDE CONCENTRATIONS IN WELLS USGS 2 AND USGS 3

SOURCE: GERAGHTY AND MILLER, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

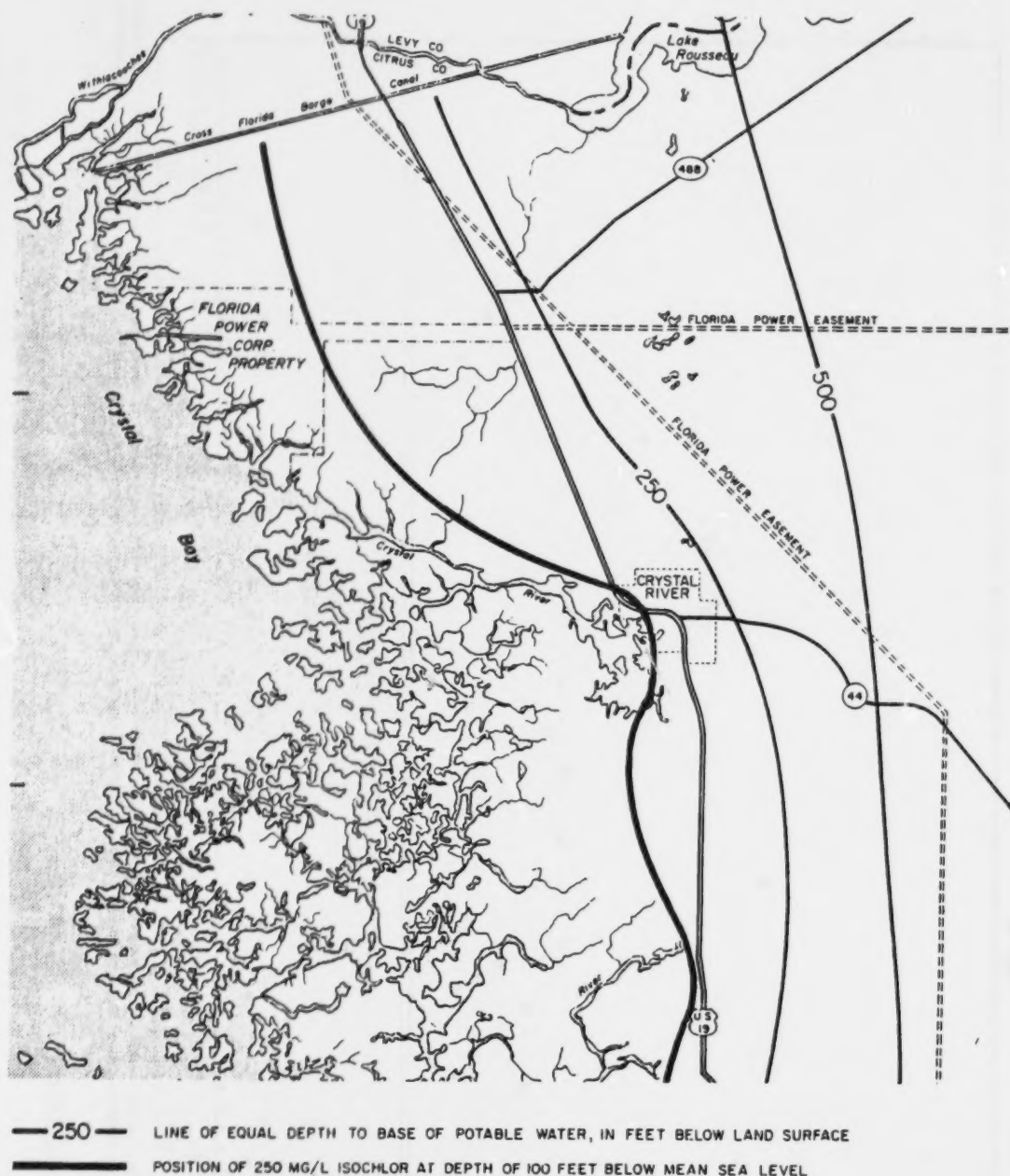


Figure 2.5-8
DEPTH TO BASE OF POTABLE WATER IN THE FLORIDAN
AQUIFER

SOURCE: GERAGHTY AND MILLER, INC., 1977



0 1 2
 SCALE IN MILES

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

2.5.2 SURFACE WATER

The major surface water features in the vicinity of the proposed plant include the Withlacoochee River-Cross Florida Barge Canal Complex to the north, Crystal River to the south, and the Gulf of Mexico to the west. Numerous small ponds and wet depressions, as well as several small unnamed intermittent streams, are scattered about the area.

Rainfall in the area averages about 1,422 millimeters (56 inches) annually and varies throughout the year. Rainfall is greatest in the summer months, due primarily to thunderstorms. Rainfall is lower in the winter and spring months when precipitation is usually the result of slow-moving frontal systems. Figure 2.5-9 shows the average monthly rainfall in the area measured at Inverness, Florida, 40 kilometers (25 miles) southeast of the site.

Runoff in the area ranges from 0 to 510 millimeters (0 to 20 inches) annually and is generally highest near the coast (Kenner, 1966). Here, runoff is supplemented by discharges from the Floridan aquifer, which is close to the land surface in the area. The numerous springs in the area (Rainbow Springs, Homosassa Springs, Chassahowitzka Springs, etc.) are discharges from the Floridan aquifer.

The USGS maintains flow measurement stations and water level recorders on surface waters in the area. Table 2.5-2 summarizes the major characteristics of gages on streams in the area and Table 2.5-3 summarizes the characteristics of gaged lakes in the area.

Major streams in the area include the Withlacoochee River-Cross Florida Barge Canal Complex, Rainbow Springs, and the Crystal River. The major lake in the area is Lake Rousseau (an artificial impoundment on the Withlacoochee River).

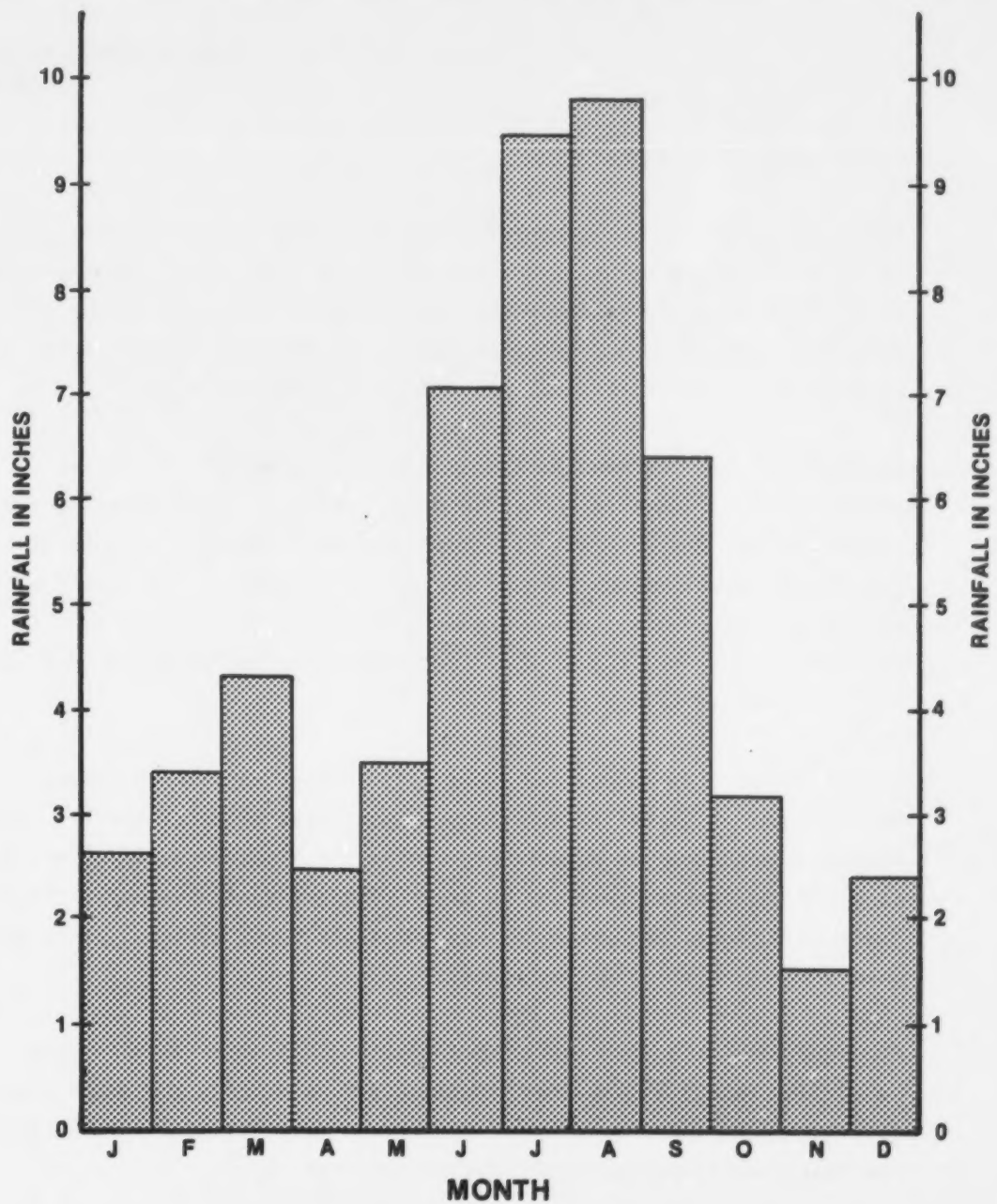


Figure 2.5-9
AVERAGE MONTHLY RAINFALL AT INVERNESS,
FLORIDA (1899 - 1975)
AVERAGE ANNUAL RAINFALL - 56.29 INCHES

SOURCE: U.S. DEPARTMENT OF COMMERCE, NOAA, 1975

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Table 2.5-2 USGS Streamgaging Network in Vicinity of Proposed Plant

Station Name	USGS ID Number	Period of Record	Ave. Flow cfs	Max. cfs	Min. cfs
Crystal River near Crystal River, Florida	02310750	2/64 to Present	916	4340	-1520
Withlacoochee River near Holder, Florida	02313000	8/28-2/29 8/31 to Present	1132	8660	112
Rainbow Springs near Dunnellon, Florida	02313100	10/30-11/64 12/64 to Present	748	1230	487
Withlacoochee River at Dunnellon, Florida	02313200	2/63 to Present	--	--	--
Withlacoochee River at Inglis Dam, near Dunnellon, Florida	02313230	10/69 to Present	481	3980	70
Withlacoochee River below Inglis Dam, near Dunnellon, Fla.	02313231	6/64 to Present	--	--	--
Cross-Florida Barge Canal at Inglis Lock, near Inglis, Florida	02313237	1/70 to Present	--	138	0
Withlacoochee River bypass channel near Inglis, Florida	02313250	1/70 to Present	1103	1740	53
Withlacoochee River bypass channel below structure, near Inglis, Florida	02313251	12/69 to Present	--	--	--
Withlacoochee River near Crackertown, Florida	02313265	4/67 to Present	--	--	--

Source: USGS Water Resources Data for Florida, 1976.

Table 2.5-3 Lake Stages in Vicinity of Proposed Plant

	USGS ID Number	Drainage Area	Surface Area	Period of Record	Maximum Elevation		Minimum Elevation	
					(msl)	(date)	(msl)	(date)
Lake Rousseau near Dunnellon, Florida	523,180	1,686 ha.			8.54 m.		6.61 m.	
	02313229	2,020 sq. mi.	4,163 acres	Jun. 1964-Present	28.01 ft.	6/26/71	21.70 ft.	10/11/72

Source: USGS Water Resources Data for Florida, 1976.

LOWER WITHLACOOCHEE-CROSS FLORIDA BARGE CANAL COMPLEX

The Withlacoochee River rises in the Green Swamp area of west central Florida at an elevation of approximately 38 meters (125 feet) above mean sea level (msl). The river meanders in a predominantly northwest direction for some 257 kilometers (160 miles) before discharging into the Gulf of Mexico. At the mouth, the Withlacoochee drains some 518,000 hectares (2,000 square miles). From the headwaters in Polk County to the town of Lacoochee in Pasco County, the river has a relatively steep slope of 0.5 meters (1.6 feet) per mile. Between Lacoochee and Dunnellon in Marion County, the slope is reduced to 6 centimeters (0.2 feet) per mile. From Dunnellon to the Gulf, the slope averages 24 centimeters (0.8 feet) per mile (U.S. Army Corps of Engineers, 1976).

The average flow of the Withlacoochee River at its mouth is approximately 51,535 liters per second (1,820 cubic feet per second) with a maximum and minimum flow of 258,890 liters per second (9,130 cubic feet per second) and 23,502 liters per second (830 cubic feet per second), respectively. Statistical flow data for the Withlacoochee River at Holder are summarized below. The drainage area is 442,890 hectares (1,710 square miles) at Holder.

Minimum daily flow	3,200 lps	113 cfs
Average annual discharge	33,130 lps	1,170 cfs
Average runoff per square mile	19 lps	0.68 cfs
Mean annual flood	99,106 lps	3,500 cfs
Maximum flood of record	244,650 lps	8,640 cfs

In view of the magnitudes of the stream flows and their geographic locales, the Withlacoochee and Crystal Rivers have little effect on surface water elevations at the plant site. However, freshwater inflows, particularly those of the Withlacoochee, play a significant role in the dispersion and movement of the near-shore waters of the Gulf.

LAKE ROUSSEAU

Lake Rousseau is an artificial impoundment of the Withlacoochee River northeast of the proposed plant site. The lake lies in a gap in a sandy ridge, known as the Brooksville Ridge, which parallels the Gulf Coast. The Brooksville is a karst highland characterized by sandy terrain and sandhill vegetation. Lake Rousseau was created in 1909 by the construction of an earthen dam. A concrete control structure consisting of two spillway bays with vertical lift gates presently exists. The initial purpose of the lake was for hydroelectric generation; however, the lake is used primarily for recreation today.

The normal surface area of the lake is 1,481 hectares (3,657 acres). Average pool elevation of Lake Rousseau is 8.2 meters (27 feet) above msl. Since 1964, the maximum stage of the lake was 8.54 meters (28.01 feet) above msl (June 26, 1971), the minimum stage was 6.61 meters (21.7 feet) above msl (October 11, 1972) (USGS, 1976). Figure 2.5-10 shows the inflow-duration curve for Lake Rousseau.

The flow of water into Lake Rousseau is gauged by the USGS at Rainbow Springs, on the Withlacoochee River at Holder and on the Withlacoochee River at Dunnellon. The gauge at Dunnellon is in the backwater of Lake Rousseau. Therefore the inflow is considered the sum of flows at Rainbow Springs and Holder (Rabon, 1966). No significant tributaries downstream of Holder occur. The discharge of Rainbow Springs for any month can be predicted within 15 percent expected accuracy two-thirds of the time (one standard deviation) using the 1931-1965 flow records. The regularity of Rainbow Springs discharge indicates that the total flows into Lake Rousseau vary with the discharge at Holder, and the discharge of the Withlacoochee River at Holder varies greatly.

The quantity of water available to Lake Rousseau (hydrologic budget) at any time is equal to:

$$(\text{Inflow} + \text{Precipitation} + \text{Seepage}) - (\text{Outflow} + \text{Evapotranspiration} + \text{Infiltration} + \text{Consumptive Demand})$$

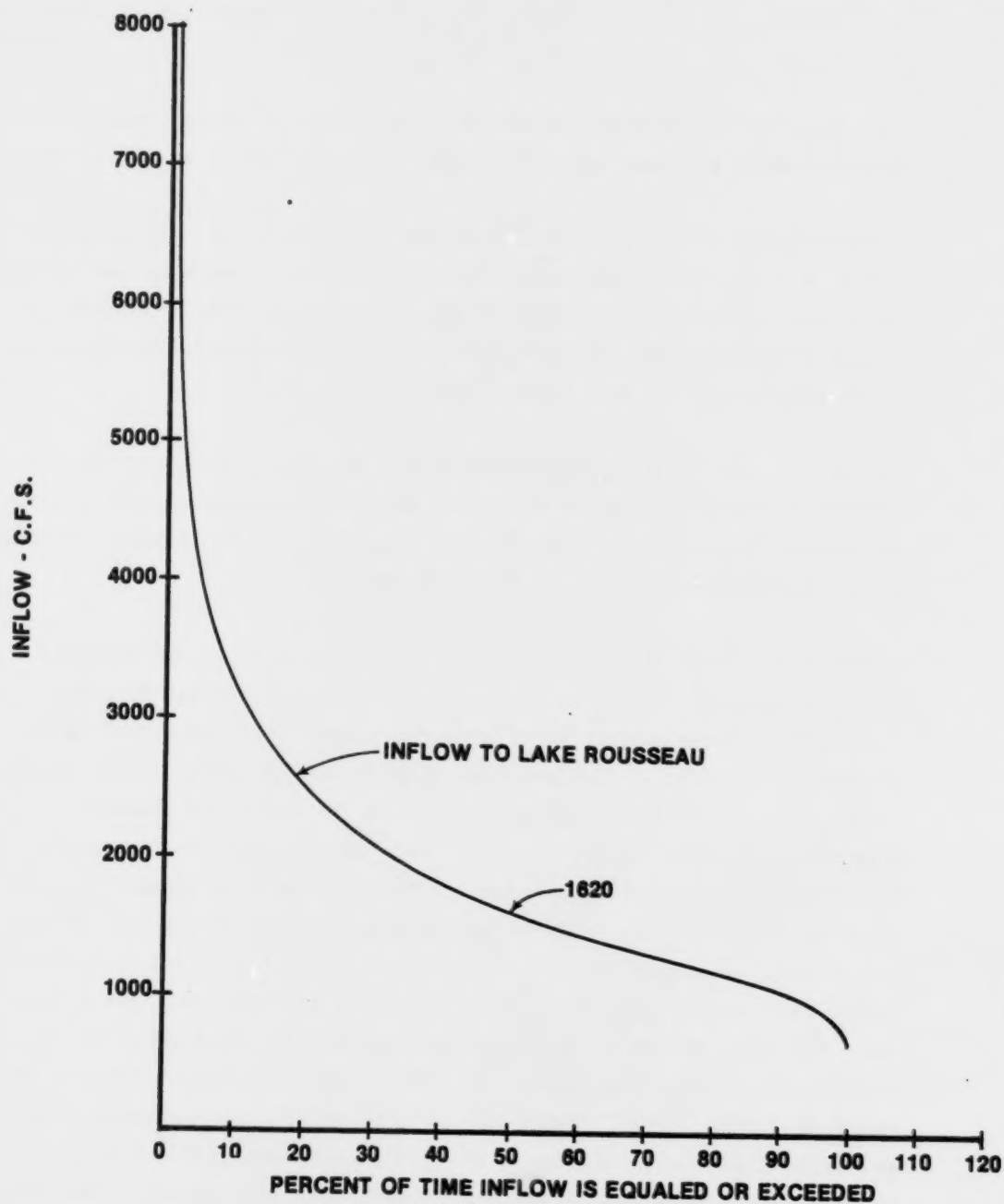


Figure 2.5-10
INFLOW - DURATION CURVE FOR LAKE ROUSSEAU

SOURCE: U.S. ARMY CORPS OF ENGINEERS, 1978

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

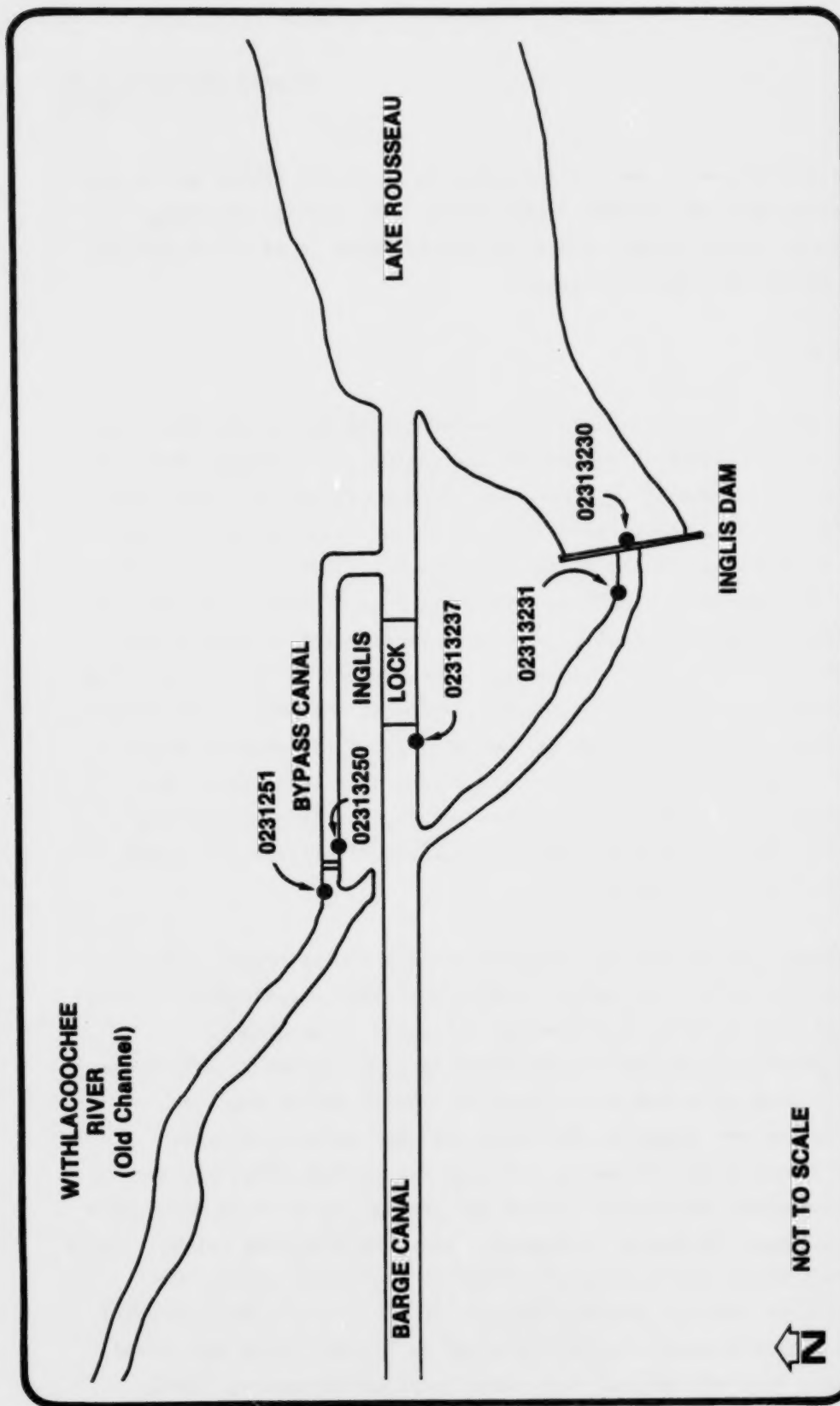
CITRUS COUNTY, FLORIDA

This equation can be analyzed by daily, monthly, or annual terms. Flood levels of Lake Rousseau are controlled by tainter gates at Inglis Dam.

Presently very little is known about the circulation of Lake Rousseau. Dissolved oxygen data indicates decreasing vertical exchange and mixing downstream of the Withlacoochee River. Near Inglis Dam, dissolved oxygen stratification indicates little vertical mixing taking place and a tendency towards oxygen depletion most of the year.

The flow of the lower Withlacoochee River near the plant site has been altered by the installation of canals and structures associated with the partially completed Cross-Florida Barge Canal. A schematic diagram of the lower Withlacoochee is shown in Figure 2.5-11.

In December, 1969, flow over the Inglis Dam was stopped and diverted into the barge canal. Some discharge still occurs through the dam (leakage) and averages 13,620 liters per second (481 cubic feet per second) (USGS, 1975). The diverted flow maintains water levels in the barge canal and Inglis Lock, as well as in the old river channel. Diverted flow which enters the old river channel does so through the Withlacoochee River Bypass Channel. Flow through this bypass channel began on December 17, 1969, and has averaged 31,233 liters per second (1,103 cubic feet per second) since that time. Flow in the barge canal itself is minimal, with most flow being diverted into the bypass channel. The USGS maintains discharge and stage gages throughout the lower Withlacoochee-Barge Canal Complex. The location of these gages is provided on Figure 2.5-11. Prior to the installation of the Barge Canal and associated works, discharge of the Withlacoochee River averaged about 50,970 liters per second (1800 cubic feet per second). The estimated capacity of the Withlacoochee Bypass Channel is approximately 45,306 liters per second (1600 cubic feet per second). Seasonal high discharges to the lower river can no longer occur because of the small capacity of the bypass channel. Therefore, the long term average discharge before construction of the barge-canal complex cannot be maintained. The future long-term average discharge to the lower river



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 2.5-11
SCHEMATIC DIAGRAM OF THE LOWER-WITHLACOOCHEE CROSS-FLORIDA
BARGE CANAL COMPLEX

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

through the bypass channel is estimated to be 40,492 liters per second (1430 cubic feet per second) (Bush, 1972). The average discharge through the bypass channel since its installation is 31,233 liters per second (1103 cubic feet per second).

CRYSTAL RIVER

The Crystal River is a tidally influenced spring-fed stream which rises at a group of springs in and around the community of Crystal River in an embayment known locally as Kings Bay. From Kings Bay the river flows easterly some 11.3 kilometers (7 miles) to the Gulf of Mexico. The estimated drainage area is 20,720 hectares (80 square miles) (Cherry, 1970). The channel, which ranges in depth from 0.6 meters (2 feet) to more than 6 meters (20 feet), is relatively wide and in many places, weed-choked. Fresh water flow in the river is due to springs in Kings Bay, numerous springs east of the bay, seeps in the many canals excavated into the limestone bedrock, and springs in the smaller tributaries. Flow in the Crystal River is measured by the USGS at the upstream confluence of the Salt River and Crystal River. Over the period of 1965 to 1975 discharges averaged 25,937 liters per second (916 cubic feet per second).

The maximum flow carried by the river channel during normal tides is about 113,264 liters per second (4,000 cubic feet per second). During hurricane Dora in 1964, the flow was estimated at more than 283,160 liters per second (10,000 cubic feet per second). Due to the unusually high hurricane tides, reverse flow of the spring over 42,474 liters per second (1,500 cubic feet per second) occurred. Reverse spring flows are not peculiar in the Crystal River and are related to tidal amplitudes. Since the springs occur at or below mean sea level their discharge is primarily controlled by tide height. Large discharges occur during seasonal low tidal amplitudes and are not reflective of rainfall periods (Cherry, et al., 1970). The estimated average annual minimum flow in the river is 12,742 liters per second (450 cubic feet per second) (U.S. Army Corps of Engineers, (1977).

Due to the estuarine nature of the Crystal River, the water chemistry varies from nearly marine at the mouth to fresh at the head. There is little vertical density or salinity stratification in the water column, but considerable longitudinal variation. The vertical homogeneity and mixing are driven by the tidal currents (ESE, 1977).

SITE HYDROLOGY

Of the 1,411 millimeters (56 inches) of rain which falls in the area each year, most is stored in small depressions and eventually returned to the atmosphere by evapotranspiration. Cherry, et al. (1970) reported that between 55 and 75 percent of the annual rainfall is evaporated. The remainder percolates through the thin sands and provides recharge to the Floridan Aquifer. The recharge water generally moves laterally and is discharged through numerous coastal and offshore springs.

The hydrology on the site is characterized by the free interconnection between surface waters and the Floridan Aquifer. The Gulf of Mexico, 1.6 kilometers (1 mile) west of the site, has a wide, marshy shoreline which comprises the westernmost portion of the site. The USGS maintains a water level and discharge gage on the Crystal River, about 8 kilometers (5 miles) southeast of the site. The mean tidal range at this gage is approximately 1.1 meters (3.50 feet).

The tide is semidiurnal with two high tides and two low tides occurring each lunar day (about 25 hours). In 1976 the mean higher highwater (MHHW) elevation at the gage was 0.53 meters (1.74 feet) above mean sea level while the mean lower low water (MLLW) was 0.23 meters (0.77 feet) below mean sea level. Since USGS records began in 1964, the highest water recorded at the Crystal River gage was 1.7 meters (5.48 feet) above mean sea level, which occurred September 11, 1964, during a hurricane. USGS Crystal River stage heights are fairly representative of the plant site.

In the western portions of the site, tidal waters are present. The eastern upland portion of the site is influenced by fresh water. The transitional boundary separating the brackish tidal waters and predominantly fresh upland water occurs at approximately the 1-meter (3-foot) msl contour. Above the 1-meter (3-foot) contour, fresh water occurs as small swampy depressions and bayheads. Defined drainage channels are virtually nonexistent on the site. Numerous small pockets of fresh water exist in other vegetation types but are too small to accurately delineate.

Because of the free connection between the surface marshes in the area and the Floridan Aquifer, water levels in the marshes are subject to water level changes in the Floridan Aquifer. Cherry, et al. (1970), report that the seasonal water level fluctuation in the area averages 1 meter (3 feet). During the wet summer months, recharge to the aquifer is greatest; therefore water levels in the marshes and bayheads rise to a point that some interconnection and exchange of water occurs. In the drier winter months, recharge is reduced and water levels drop accordingly.

Perhaps the most conspicuous hydrologic features near the site are the two man-made canals built by FPC to provide for the intake and discharge of cooling waters. These canals have drained wetlands adjacent to them. In addition, the canals have allowed some further inland penetration of the salt water wedge (Geraghty and Miller, 1977).

SURFACE WATER QUALITY

The State of Florida, Department of Environmental Regulation (DER) has classified all the surface waters in the state, according to quality and usage into the following five categories:

- Class I--Public water supply
- Class II--Shellfish harvesting
- Class III--Recreation and propagation of fish and wildlife
- Class IV--Agricultural and industrial water supply
- Class V--Navigation, utility, and industrial use

The offshore Gulf waters are presently Class II waters, while the upland surface waters are all Class III.

The Crystal River Units 4 and 5 are located in the U.S. Geological Survey Basin 10J. Surface water in this basin is classified by DER as Class III (Recreation, Propagation, and Management of Fish and Wildlife). There are no exceptions to the Class III water in the proposed plant site.

The water quality standards for Class III waters as set forth in FAC Chapter 17-3.121 were established to protect the beneficial use of the water from pollutant discharges. The standards include physical (e.g., transparency), chemical (e.g., nutrients, metals), and biological (e.g., bacteriological) parameters for both aquatic and marine systems. The water quality standards are administered by DER.

The water quality criteria for Class III waters are shown in Table 2.5-3a. The extent of Class II waters in Citrus County, as determined by DER in FAC Chapter 17-3.161, is:

"Tidal Creeks and coastal waters--Latitude 28°54'N, south to Hernando County Line with the exception of waters which are bounded by and including the Crystal River on the north, St. Martin's River on the south, barrier islands on the west, and the mainland on the east."

Additional exceptions to Class III waters in the county are the Chassahowitzka Wildlife Refuge and the St. Martin's Marsh State Aquatic Preserve.

The Florida DER has also prepared draft Water Quality Management plans for the area. These plans break the west central Florida area into easily analyzed hydrologic units called segments, based on drainage

Table 2.5-3a. FAC 17-3 Water Quality Criteria--General

Parameters	Standards
Arsenic	0.05 mg/l
BOD ₅	Shall not depress DO below 4 mg/l instantaneous and 5 mg/l 24-hour average
Chloride	250 mg/l (freshwater) <10% above ambient (marine)
Chromium (Hexavalent)	0.50 mg/l (effluent)
Chromium (Total)	1.0 mg/l (effluent)
Total	0.05 mg/l (receiving water)
Copper	0.5 mg/l
Detergents	0.5 mg/l
Dissolved Solids	500 mg/l (monthly average) 1,000 mg/l (instantaneous)
Fluorides--ionic	10.0 mg/l
Lead	0.05 mg/l
Oil and Grease	
Dissolved or Emulsified	5.0 mg/l
Undissolved	No visible oil to interfere with beneficial use
pH--Variation from natural background	<+ 1.0
Range	6.0 to 8.5 (fresh)
Range	6.5 to 8.5 (marine)
Phenoloic Compounds	0.001 mg/l
Radium 226 and 228	<5 picu/l
Gross Alpha Particle Activity	<15 picu/l
Specific Conductance	<100% increase above ambient 500 umhos/cm (freshwater)
Turbidity	<50 JTU increase above ambient
Zinc	1.0 mg/l

7/2/80

Table 2.5-3a. Water Quality Criteria--Class III (17-3.121) Surface Waters Recreation, Propagation, and Management of Fish and Wildlife (Continued, Page 2 of 3)

Parameters	Fresh Waters	Marine Waters
Alkalinity as CaCO ₃	>20mg/l	NA
Aluminum	NA	1.5 mg/l
Ammonia (un-ionized)	0.02 mg/l	NA
Antimony	NA	0.2 mg/l
Fecal Coliform	200 counts/100ml--monthly average 400 counts/100ml--10% of samples per month 800 counts/100ml--on any one day	
Total Coliform	1,000 counts/100ml--monthly average 1,000 counts/100ml--<20% of samples per month 2,400 counts/100ml--at any time	
Beryllium	0.11 mg/l if CaCO ₃ hardness <150 mg/l) 1.10 mg/l if CaCO ₃ hardness >150 mg/l)	
Biological Integrity	3 Hester-Dendy, 3 Ponar Grabs	
Shannon-Weaver D.I.	Substances >75% of established background	
Bromine	NA	0.1 mg/l
Bromate	NA	100 mg/l
Cadmium	1.2 ug/l if hardness >150 mg/l 0.8 ug/l if CaCO ₃ <150 mg/l	5.0 ug/l
Chlorine (total residual)	0.001 mg/l	0.01 mg/l
Copper	30 ug/l	15 ug/l
Cyanide	5.0 ug/l	5.0 ug/l
Dissolved Gasses	110% saturation value	
Dissolved Oxygen	5.0 mg/l	5.0 mg/l (24-hr avg.)
	NA	4.0 mg/l (instantaneous)
Fluoride	NA	5.0 mg/l
Hydrogen Sulfide (undissociated)	0.002 mg/l	0.002 mg/l
Iron	1.0 mg/l	0.3 mg/l
Lead	30 ug/l	50 ug/l (general)
Manganese	0.1 mg/l	0.1 mg/l (shell fish)
Mercury	0.2 ug/l	0.1 ug/l
Nickel	0.1 mg/l	0.1 mg/l
Nutrients	Waters should be protected from man-induced nutrient enrichment	

7/1/80

Table 2.5-3a. Water Quality Criteria--Class III (17-3.121) Surface Waters Recreation, Propagation, and Management of Fish and Wildlife (Continued, Page 3 of 3)

Parameters	Fresh Waters	Marine Waters
Pesticides and Herbicides		
Aldrin plus Dieldrin	0.003 ug/l	0.003 ug/l
Chlordane	0.01 ug/l	0.004 ug/l
DDT	0.001 ug/l	0.001 ug/l
Demeton	0.1 ug/l	0.1 ug/l
Endosulfan	0.003 ug/l	0.001 ug/l
Endrin	0.004 ug/l	0.004 ug/l
Guthion	0.01 ug/l	0.01 ug/l
Heptachlor	0.001 ug/l	0.001 ug/l
Lindane	0.01 ug/l	0.004 ug/l
Malathion	0.1 ug/l	0.1 ug/l
Methoxychlor	0.03 ug/l	0.03 ug/l
Mirex	0.001 ug/l	0.001 ug/l
Parathion	0.04 ug/l	0.04 ug/l
Toxaphene	0.005 ug/l	0.005 ug/l
pH--Variation from natural background waters	+ 1.0	+ 1.0 (coastal) + 0.2 (open water)
Range	6.0 to 8.5	6.5 to 8.5
Phosphorus--elemental	NA	0.1 ug/l
Phthlate Esters	0.003 mg/l	NA
Polychlorinated Biphenyls	0.001 ug/l	0.001 ug/l
Selenium	0.025 mg/l	0.025 mg/l
Silver	0.07 ug/l	0.05 ug/l
Transparency	<10% reduction of compensation depth from background	
Zinc	30 ug/l	1.0 mg/l (general)

divides. Generally, the plans assess the water quality within each segment and make recommendations concerning assimilation capacities and waste load allocations. The proposed site is located in the northern portion of segment 24.4AA. The plans assess water quality in the Crystal River and the lower Withlacoochee River/Cross-Florida Barge Canal.

Generally, water quality in the Crystal River is considered good except for periodically high concentrations of total nitrogen. In the period November 1972, to November 1975, total nitrogen concentrations in Crystal River averaged 0.35 mg/l. Segment 24.4AA is classified as an "effluent limited segment", meaning that potential discharges must have at least standard secondary treatment.

The other major surface water feature of the area is the lower Withlacoochee River which is designated as segment 23.1AA. This is a "water quality limited" segment, meaning that potential discharges must receive something above standard secondary treatment. According to the Withlacoochee River Basin Water Quality Management Plan (Florida DER, 1975), water quality in the lower Withlacoochee is good with the exception of coliform bacteria levels, which from Holder to the mouth of the river are "unacceptably high" (average 1624 organisms per 100 ml, 49 samples, 9/68-1/74). Dissolved oxygen is acceptable near the mouth but decreases upstream. In the Cross-Florida Barge Canal, the plan recognizes high total nitrogen concentrations (1.13 mg/l, average of 2 samples, 11/73-1/74) and high coliform bacteria levels. Of 27 samples taken in the canal between March 1970 and June 1971, 10 had dissolved oxygen concentrations of less than 5.0 mg/l. The average of the 27 samples was 5.6 mg/l. Figure 2.5-12 shows seasonal vertical dissolved oxygen and temperature profiles of the Withlacoochee River and Lake Rousseau.

The quality of water in Lake Rousseau is dependent upon the quality of the Withlacoochee River inflow waters (Environmental Research and Technology, 1976).

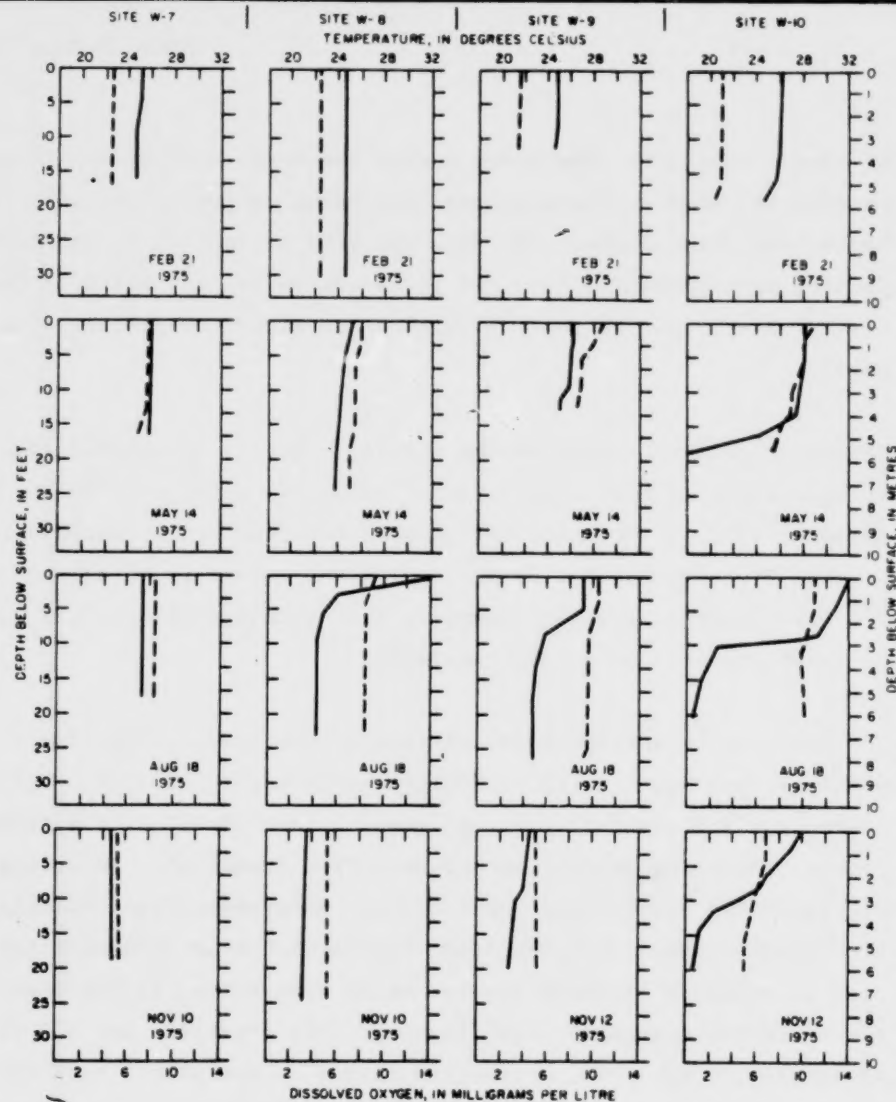


Figure 2.5-12
PROFILES OF TEMPERATURE AND DISSOLVED OXYGEN
IN LAKE ROUSSEAU

SOURCE: USGS WATER-RESOURCES INVESTIGATIONS NO. 76-23, 1976

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Water samples were collected at Lake Rousseau and Crystal River in late August 1977, (ESE, 1977). Results of all analyses are presented in Table 2.5-4. The surface sample data for Lake Rousseau is comparable to data taken in August 1975, by USGS (Environmental Research and Technology, 1976). Unfortunately the USGS has not collected vertical samples except for dissolved oxygens. The variability of other water quality parameters in deeper portions of the lake is undocumented. A dissolved oxygen sag which occurs most of the year near the Inglis Dam is probably due to benthic demand.

On a seasonal basis there is a potential for resuspension of very fine sediments. Water quality in the lake is generally good; however, high concentrations of suspended material may occur due to seasonal processes.

The DER attributes the low dissolved oxygen values in the area to natural causes and states that some "additional dissolved oxygen demand may result from aquatic weed control." High coliform levels in the lower Withlacoochee may be attributed to runoff from agricultural areas and possibly septic tank leakage. The nitrogen, dissolved oxygen, and coliform problems in the Cross-Florida Barge Canal are attributed to the "decaying aquatic environment of the reservoirs above."

In Lake Rousseau, none of the parameters analyzed by ESE for August samples show evidence of water quality degradation. In the Crystal River, samples were taken during a falling tide; therefore, only the downstream site exhibits moderately saline conditions. Accordingly, values of hardness, dissolved solids, and suspended solids increase downstream. All other parameters are within acceptable limits and do not vary significantly among the three locations.

Table 2.5-4 Water Quality Analysis--Crystal River and Lake Rousseau
(Samples taken August 29, 30, 1977)

	Water		Salinity (ppt)	pH	Dissolved		Turbidity (NTU)	Color (CPO)	Total Solids (mg/l)	Susp. Solids (mg/l)	Dissolved Solids (mg/l)	Alkalinity (mg/l CaCO ₃)
	Temp. (°C)				Oxygen (mg/l)							
Crystal River												
Upstream (Surface)	25.2		0	7.3		6.8	0.7	10	860	<5	855	100
Upstream (Depth)	25.8		0	7.4		6.0	1.4	0	980	<5	975	100
Midstream (Surface)	26.4		0	7.4		6.6	3.0	5	2,100	12.7	2,087	105
Midstream (Depth)	26.2		0	7.4		7.1	3.7	5	2,300	9.6	2,290	108
Downstream (Surface)	26.5		0	7.4		6.1	2.3	0	3,600	7.7	3,592	112
Downstream (Depth)	27.0		2.3	7.1		5.8	2.6	10	4,020	11.3	4,009	109
Lake Rousseau												
Near Shore (Surface)	28.0		NA	7.7		7.2	1.4	5	130	<5	125	86
Near Shore (Depth)	28.0		NA	7.5		7.2	1.7	10	159	12.2	147	80
Off Shore (Surface)	27.2		NA	7.6		7.1	2.1	5	140	7.0	133	84
Off Shore (Depth)	27.2		NA	7.6		6.8	2.2	10	140	24.5	115	86

Table 2.5-4 (Continued, page 2 of 2)

	NO ₃ and NO ₂ (mg N/l)	NH ₃ (mg N/l)	TKN (mg N/l)	Ortho PO ₄ (mg P/l)	Total PO ₄ (mg P/l)	BOD (mg/l)	Hardness (mg/l CaCO ₃)
Crystal River							
Upstream (Surface)	.019	<.02	0.52	.096	0.16	<1.0	228
Upstream (Depth)	.011	<.02	0.33	.024	0.14	<1.0	234
Midstream (Surface)	.006	<.02	0.50	.011	0.11	<1.0	418
Midstream (Depth)	.013	<.02	2.60	.016	0.16	<1.0	438
Downstream (Surface)	.054	.032	.66	.016	0.10	<1.0	672
Downstream (Depth)	.016	.027	.015	.015	0.099	<1.0	786
Lake Rousseau							
Near Shore (Surface)	0.16	<.02	0.22	.002	0.090	<1.0	102
Near Shore (Depth)	.008	<.02	0.34	.003	0.13	1.1	128
Off Shore (Surface)	<.004	<.02	0.68	<.002	0.16	<1.0	108
Off Shore (Depth)	.018	<.02	0.36	<.002	0.093	1.0	86

Source: Environmental Science and Engineering, Inc., 1977.

Discharge Basin

There are four principal sources of water entering the discharge basin. These include the Gulf Shelf water, thermal discharges from Units 1, 2, and 3, fresh water from the Withlacoochee River Barge Canal, and local rainfall runoff. These sources contribute to the temperature and salinity characteristics of the basin. The Gulf Shelf water entering the basin from the west northwest is of primary importance. Salinity characteristics of the Gulf Shelf water are relatively stable (averaging 31 percent); however, temperature conditions vary seasonally with a mean range of about 11°C (Behrens, 1975).

Water comprising the thermal effluent of the existing power plants is, for the most part, of Gulf Shelf origin (Carder, *et. al*, 1974). The average salinity of the discharge water is 28.5 parts per thousand.

Slight salinity reductions occur occasionally as a result of dilution by river water during periods of high runoff. At such times salinity decreases are in the order of 50 percent. The effluent temperature fluctuates according to ambient Gulf water temperatures and power plant load. Under normal conditions, a mean temperature rise of 11.5°C can be expected when both fossil fuel units are in operation (Behrens, 1975).

The most significant salinity variations in the discharge basin result from the discharge of fresh water from the Withlacoochee Barge Canal Complex. The Withlacoochee Bypass discharges from Lake Rousseau into the Withlacoochee River then to the Gulf while the main spillway discharges into the Cross-Florida Barge Canal and into the Gulf. There appears to be an initial lag period between the time of rainfall and the increase in discharge from the reservoir.

The effects of direct precipitation on temperature and salinity conditions in the discharge basin are primarily short lived and difficult to measure. They would be expected to be significant, particularly after

the heavy afternoon thunder showers which occur frequently throughout the summer. However, the magnitude of the effect of direct rainfall on temperature and salinity changes within the basin has not been determined.

Turbidity in the Gulf waters has been measured on several occasions. These results generally indicate higher turbidity during times of strong winds or tidal current flows with local sources of resuspended bottom sediments contributing heavily to the turbidity pattern during strong tidal flows. The turbidity also occurs as a result of the Withlacoochee River Cross-Florida Barge Canal network. During slack water fine sediments from these sources are deposited, especially in the shallow grassy areas where they then provide a readily available source of fine sediments for resuspension when turbulent water velocities become sufficiently great at peak ebb tide or during periods of strong winds.

An extensive study (Fox and Moyer, 1972) of solids, distribution, and turbidity at six stations (one in the intake canal and the others along the discharge canal) was performed. Only general trends can be noted in this study. The force of the water as it leaves the condenser plays an important role in the solids distribution. Material is constantly being eroded from the banks and bottom of the canal. The increase in total solids at the point of discharge probably was due to the added turbulence of the water at this point. Total solids were markedly lower in the discharge basin than at the mouth of the discharge canal.

Water Quality Parameters

Investigations have been carried out to determine seasonal patterns in water quality parameters in the Gulf coastal waters adjacent to FPC (Gibson et al.). Nutrient concentrations for this study gave a ranking silica of amplitudes as follows:

$$\text{NH}_3\text{-N} < \text{NO}_3\text{-N} < \text{SiO}_2 - 4\text{-P}$$

Silica was the only nutrient that showed an obvious trend, with the highest concentrations being found at stations proximal to the Crystal

River and Cross Florida Barge Canal stations. The lowest concentrations were found at the most seaward stations. Nitrate-nitrogen concentrations followed variations in precipitation rather closely. Such a relationship was less evident for other nutrients measured.

Salinities for the same study (Gibson, et al.) showed wide variability with season and location. The highest salinities were generally recorded at the most seaward stations and the lowest at the Cross Florida Barge Canal and Crystal River stations. Salinities ranged from 18 to 31 ppt at stations along the intake dike, 8 to 0 ppt at the Cross Florida Barge Canal, and 3.5 to 6 ppt at the Crystal River Station.

Ambient surface and discharge water temperature also fluctuated on a seasonal basis (Gibson, et al.). Ambient temperatures at the intake ranged from 11.0°C in February to 24.5°C in April, a range of 13.5°C over the sampling period. Discharge temperatures closely followed variations in ambient temperature but averaged 4.1°C higher.

Chlorophyll a measured in this study (Gibson, et al.) ranged from 0.78 to 5.11 mg per cubic meter for stations near the plant intake and discharge structures. The highest concentrations of chlorophyll a, were found near the mouth of the barge canal. Mean values at that point were 1.5 times higher than the average of stations A-I near the plant.

Studies have been carried out (Odum and Snedaker, 1972) to determine the magnitudes of phosphorus in its various forms (dissolved, particulate, organic, inorganic, etc.) in the bay and canals. The analysis indicated a relatively constant ratio among phosphorous fractions both in the intake and discharge canals. Total phosphorus was approximately 49 percent particulate, 34 percent dissolved organic, and 17 percent dissolved inorganic. Readings taken in the outer bay were generally twice those of the inner bay.

2.5.3 WATER RESOURCES SPECIFIC TO THE PROPOSED SITE FOR UNITS 4 AND 5

In the vicinity of the proposed plant site, the limestone which makes up the Floridan Aquifer is at or near land surface. Where the limestone is below land surface, it is generally covered with sand.

Limestone exposed in outcrops, ditches, and attached to roots of fallen trees exhibits extensive solution channels. This suggests a high permeability. The permeable surface (limestone and sand) and the absence of surface drainage features suggests that most of the rainfall infiltrates directly and that there is little runoff.

The water table is about 0.4 to 1 meter (1 to 4 feet) below land surface.

Table 2.5-5 gives a summary of water quality parameters from three wells currently in use for the existing plant site and from bore holes at the proposed plant site.

Table 2.5-5 Analyses of Water from Test Borings* in the Proposed Plant Site Area and Existing Site

Well No.	Date of Sample	Conductivity (micromhos/cm)	TDS (mg/l)	TSS (mg/l)	Hardness as CaCO ₃ (ppm)	Ca ⁺⁺ as CaCO ₃ (ppm)	Chloride (ppm)	Mo Alkalinity (ppm)	pH
3	2-23-78	410	--	<5	232	59	10	13.2	7.6
4	2-23-78	450	--	<5	248	77	9	16	7.4
5	2-23-78	450	--	<5	256	75	9	15	7.6
403	12-20-77	550	204	9	239	88	9.6	159	7.1
420	2-7-78	385	209	121	171	64	8.5	103	7.4
421	2-7-78	580	328	7	243	79	20	149	7.3
422	2-7-78	590	301	35	233	76	22	142	7.3
425	2-7-78	480	300	6	174	65	14	107	7.5
428	2-7-78	565	231	155	205	81	17	131	7.4

*Grab samples only.
Source: Florida Power Corporation, 1978.

2.6

CLIMATOLOGY AND DISPERSION METEOROLOGY

On-site measurements are available at Crystal River from a meteorological tower which conforms to Atomic Energy Commission accuracy specifications. There are two instrumentation levels on the tower, at 10 meters (33 feet) and 23 meters (74 feet), from which horizontal wind speed and direction are measured, as well as delta-T or lapse rate data. In addition, ambient temperature is measured on the lower level while precipitation and barometric pressure are measured from the surface.

Currently, all meteorological data goes onto strip charts, although the year 1975 has been fully digitized and is available on a magnetic tape. The data for this section was developed from 1975 data. Long-term averages are available from Tampa International Airport, the nearest representative national weather bureau station.

2.6.1 TEMPERATURE

Table 2.6-1 presents the monthly means and extremes of temperature, which are characteristic of the Crystal River site. On-site temperatures for 1975 ranged from -2.5°C (27.5°F) in December to 33.3°C (91.9°F) in August. The mean annual temperature was 21.0°C (69.8°F), whereas the 30-year Cedar Key mean annual temperature was 21.7°C (71.0°F). Temperature extremes in a 30-year period are taken from Tampa because it is the most representative station with available data.

Table 2.6-1 Monthly Means and Extremes of Temperature (°C) for Crystal River, Florida

Month	On-Site, 1975*				Cedar Key, 1941-70†			Tampa, 1947-76†	
	Mean Daily Max.	Mean Daily Min.	Mean	Highest	Lowest	Mean	Highest	Lowest	
January	20.9	11.9	16.3	25.6	0.0	13.8	28.9	-5.0	
February	21.2	13.6	17.4	26.4	3.9	14.9	31.1	-4.4	
March	21.8	12.9	17.6	28.1	3.1	17.6	32.8	1.1	
April	24.9	16.2	21.0	29.4	6.1	21.7	33.9	4.4	
May	28.1	20.4	24.5	31.9	16.7	25.2	36.7	9.4	
June	29.4	22.5	26.1	31.1	20.8	27.6	36.7	16.1	
July	28.6	23.1	26.3	31.2	20.6	28.0	36.1	17.2	
August	30.2	22.4	26.1	33.3	20.8	28.1	36.7	19.4	
September	29.2	21.4	24.9	33.1	15.6	27.2	35.6	15.0	
October	27.6	19.1	22.8	30.8	12.5	23.2	34.4	4.4	
November	22.6	13.3	17.6	29.7	1.9	18.3	32.2	-5.0	
December	18.6	8.8	13.8	25.8	-2.5	14.7	30.0	-7.8	
Annual	25.2	16.9	21.0	33.3	-2.5	21.7	36.7	-7.8	

Sources: * Florida Power Corporation, 1975.
† National Climatic Center, 1973; 1976.

2.6.2 PRECIPITATION AND HUMIDITY

Dewpoint or humidity data are not recorded on-site. However, average humidity data are summarized for Tampa four times a day, and are presented with the precipitation means and extremes in Table 2.6-2.

Precipitation and temperature can vary greatly from one year to another. For this reason, a long-term mean was included for Cedar Key. In addition, monthly and annual precipitation extremes and average humidity values are included for Tampa. As expected, the lowest humidity values coincide with the warmest time of day and vice versa. These on-site values may be slightly higher than those experienced in Tampa.

Table 2.6-2 Monthly Means and Extremes of Precipitation (Millimeters) and Relative Humidity for Crsytal River, Florida

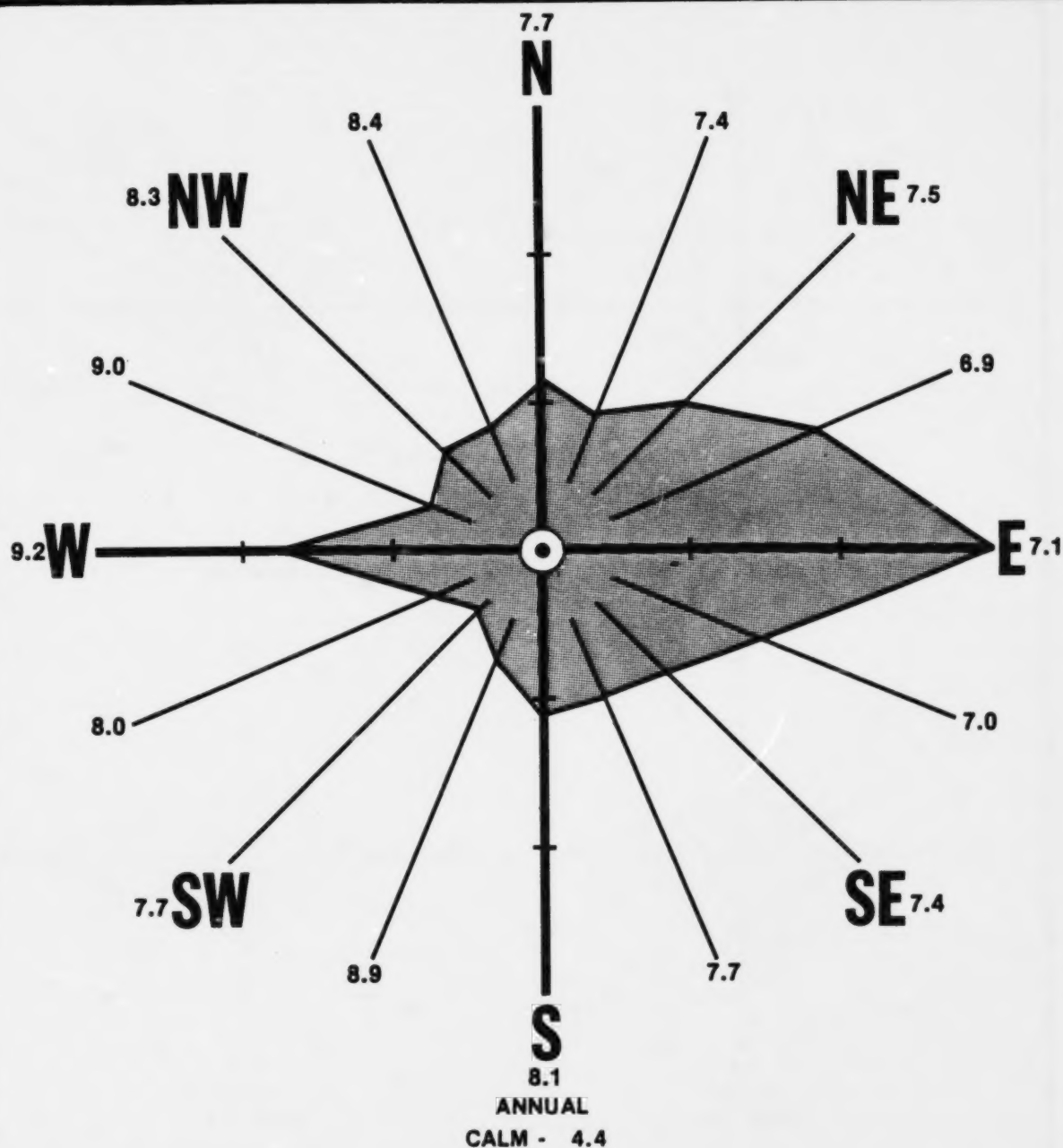
Month	On-Site 1975*	Precipitation			Humidity (Tampa, 1964-1976)			
		Cedar Key, 1941-70† Mean	Tampa, 1947-76†		Hour (LT)			
			Maximum	Minimum	0100	0700	1300	1900
January	47	68	204	T	84	86	59	73
February	123	79	202	5	81	84	55	68
March	17	98	321	2	81	85	54	66
April	15	68	167	T	81	86	49	60
May	27	52	207	4	80	84	51	61
June	98	107	349	47	82	85	59	67
July	175	208	523	57	84	86	62	71
August	168	195	472	60	86	89	63	74
September	224	162	331	33	85	89	61	74
October	87	70	187	6	84	87	56	71
November	51	36	155	T	84	86	54	73
December	45	60	169	5	83	86	57	73
Annual	1078	1201	1945	734	83	86	57	69

T = Trace WBO

Sources: * Florida Power Corporation, 1975.
† National Climatic Center, 1973; 1976.

2.6.3 WIND AND STABILITY

Wind variables are measured at two on-site levels: 10 meters (33 feet) and 53 meters (174 feet) grade. Annual and monthly wind roses (for the lower level wind instruments) are presented in Figures 2.6-1 through 2.6-2c. On an annual basis, winds at the site prevail from the east to east-northeast. However, the warmer months show appreciable sea breezes from the west and southwest. Increasing amounts of northerly winds are most evident in the cooler months. Stabilities were determined by Pasquill's method of incorporating wind speed, cloud cover, cloud ceiling, and solar elevation. Hourly cloud cover and ceiling data for 1975 were available from Tampa, while all other variables were observed on-site. Annual wind rose-stability tabulations were determined from wind speed and direction at the 10-meter (33-foot) level with stabilities as determined above. These (variables) are presented in Table 2.6-3. Monthly and annual frequencies of Pasquill's stability classes are portrayed in Table 2.6-4.



TICK MARKS ON ROSE REPRESENT 4%.
AVERAGE WIND SPEED IN KNOTS IS GIVEN FOR EACH WIND SECTOR.

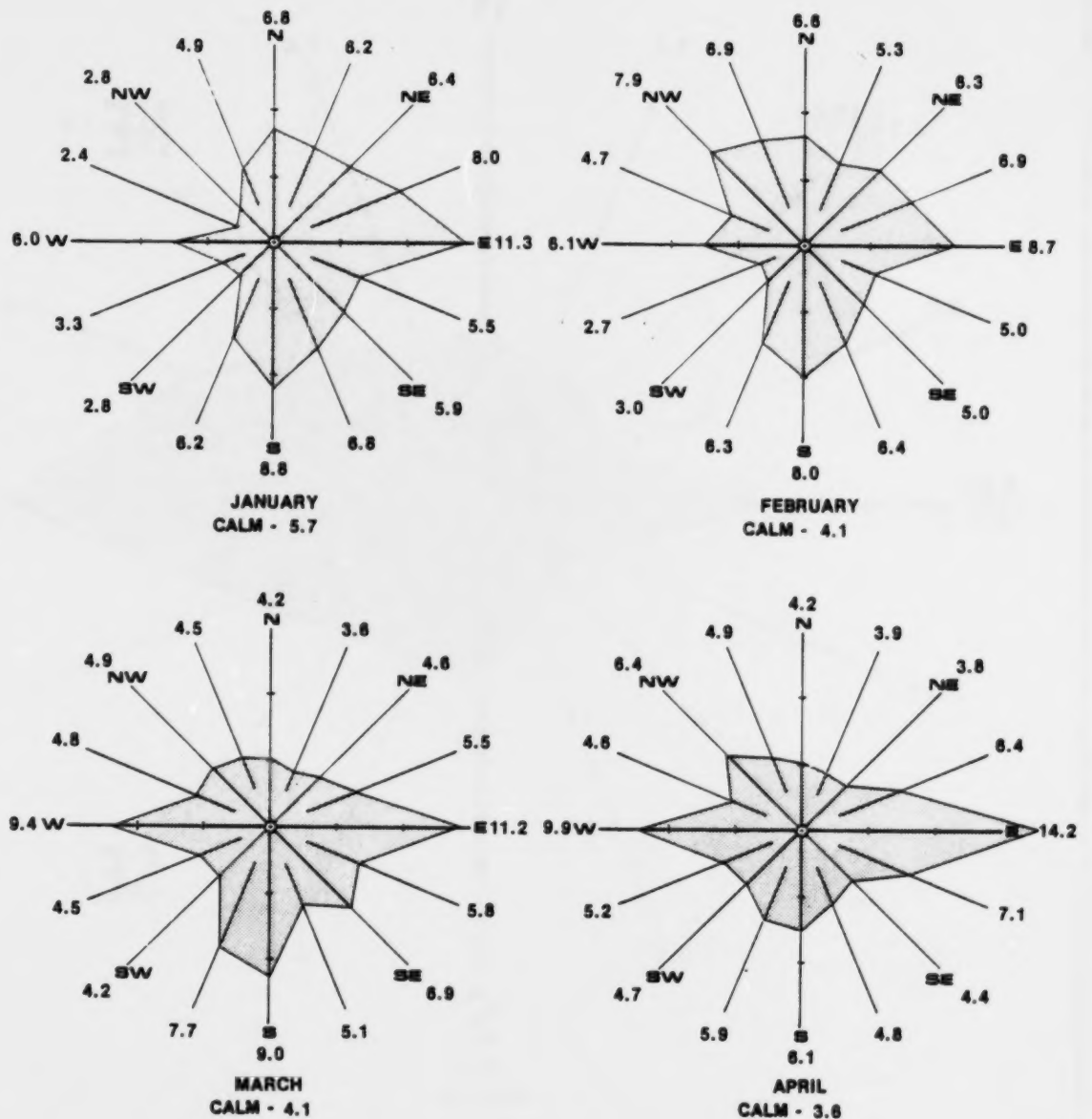
Figure 2.6-1
ANNUAL WIND ROSE FOR TAMPA, FLORIDA,
1971 - 1975

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA



TICK MARKS ON ROSE REPRESENTS 4%.
AVERAGE WIND SPEED IN KNOTS IS GIVEN FOR EACH WIND SECTOR.

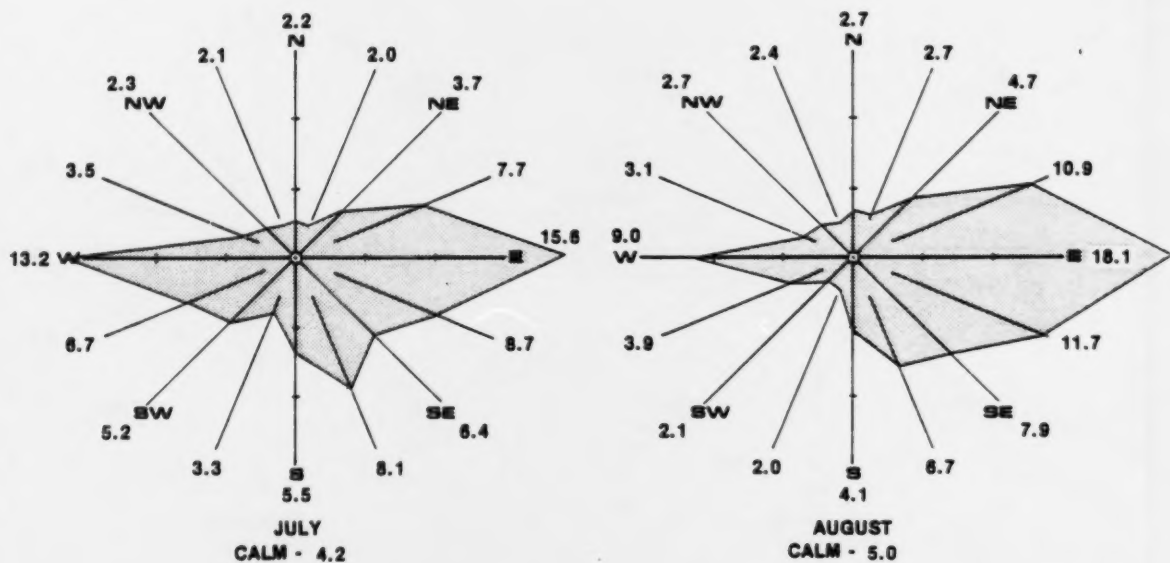
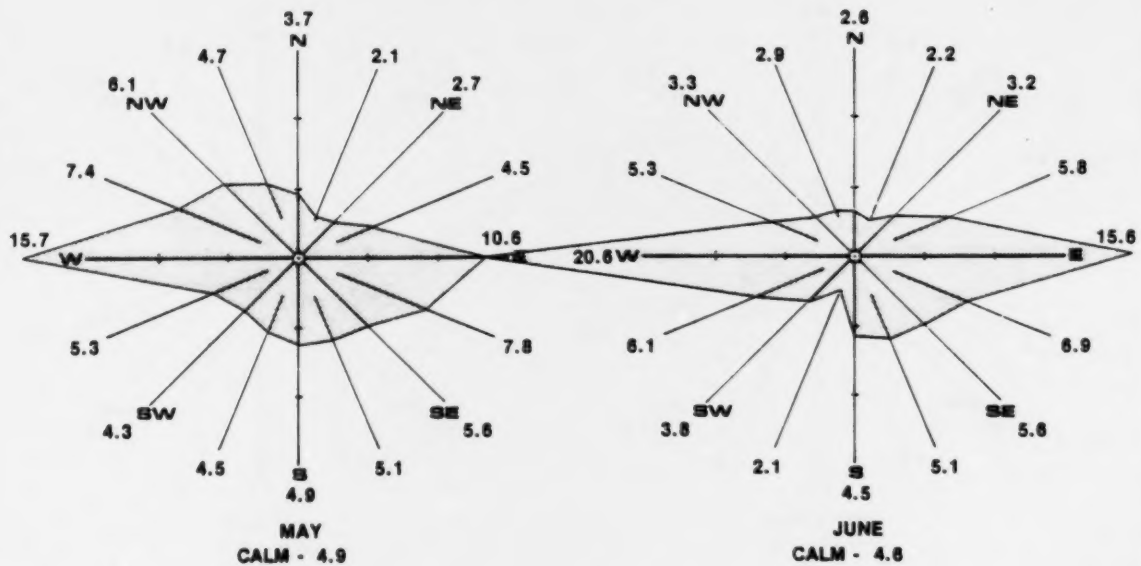
Figure 2.6-2a
JANUARY THROUGH APRIL WIND ROSES FOR TAMPA,
FLORIDA, 1971 - 1975

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA



TICK MARKS ON ROSE REPRESENTS 4%.
AVERAGE WIND SPEED IN KNOTS IS GIVEN FOR EACH WIND SECTOR.

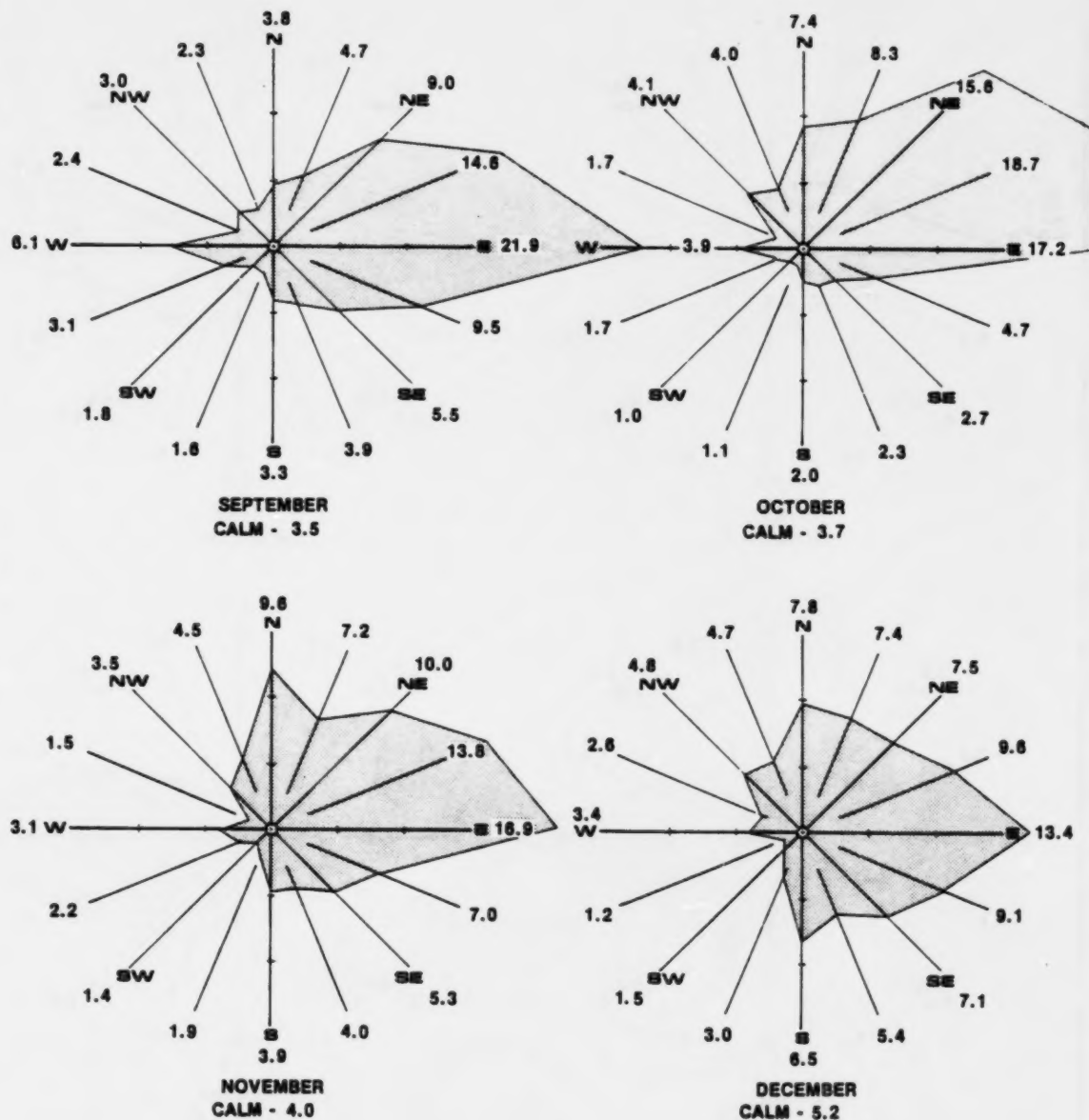
Figure 2.6-2b
MAY THROUGH AUGUST WIND ROSES FOR TAMPA,
FLORIDA, 1971 - 1975

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA



TICK MARKS ON ROSE REPRESENTS 4%.
AVERAGE WIND SPEED IN KNOTS IS GIVEN FOR EACH WIND SECTOR.

Figure 2.6-2c
SEPTEMBER THROUGH DECEMBER WIND ROSES
FOR TAMPA, FLORIDA, 1971 - 1975

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Table 2.6-3.

RELATIVE FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION, CRYSTAL RIVER, FLORIDA

DIRECTION	SPEED(KTS)						TOTAL
	0 - 3	4 - 6,	7 - 10	11 - 16	17 - 21	GREATER THAN 21	
N	0.000030	0.000115	0.0	0.0	0.0	0.0	0.000144
NNE	0.000030	0.000115	0.0	0.0	0.0	0.0	0.000144
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENE	0.000174	0.000115	0.0	0.0	0.0	0.0	0.000289
E	0.000642	0.000802	0.0	0.0	0.0	0.0	0.001444
ESE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE	0.000030	0.000115	0.0	0.0	0.0	0.0	0.000144
SSE	0.000060	0.000229	0.0	0.0	0.0	0.0	0.000289
S	0.000030	0.000115	0.0	0.0	0.0	0.0	0.000144
SSW	0.000030	0.000115	0.0	0.0	0.0	0.0	0.000144
SW	0.000149	0.000573	0.0	0.0	0.0	0.0	0.000722
WSW	0.000294	0.000573	0.0	0.0	0.0	0.0	0.000866
W	0.000418	0.001603	0.0	0.0	0.0	0.0	0.002022
WNW	0.000030	0.000115	0.0	0.0	0.0	0.0	0.000144
NW	0.000030	0.000115	0.0	0.0	0.0	0.0	0.000144
NNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.001947	0.004696	0.0	0.0	0.0	0.0	

RELATIVE FREQUENCY OF OCCURRENCE OF A STABILITY = 0.006643

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH A STABILITY = 0.001374

Table 2.6-3 (Continued, Page 2 of 6).

RELATIVE FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION, CRYSTAL RIVER, FLORIDA (CON)

DIRECTION	SPEED (KTS)						TOTAL
	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	
N	0.000303	0.001947	0.003092	0.0	0.0	0.0	0.005342
NNE	0.000066	0.001947	0.002405	0.0	0.0	0.0	0.004418
NE	0.000161	0.001260	0.006758	0.000229	0.0	0.0	0.008408
ENE	0.000365	0.003780	0.011912	0.000802	0.0	0.0	0.016858
E	0.001450	0.004352	0.012026	0.001374	0.0	0.0	0.019203
ESE	0.001143	0.002291	0.005383	0.000115	0.0	0.0	0.008932
SE	0.000322	0.002520	0.002520	0.000344	0.0	0.0	0.005705
SSE	0.000223	0.003092	0.003207	0.0	0.0	0.0	0.006523
S	0.000173	0.001603	0.005040	0.000687	0.000115	0.0	0.007618
SSW	0.000146	0.000802	0.005841	0.002176	0.000115	0.0	0.009079
SW	0.000398	0.001260	0.005612	0.002291	0.0	0.000115	0.009675
WSW	0.000303	0.001947	0.007788	0.001260	0.0	0.0	0.011298
W	0.001023	0.005727	0.019013	0.000229	0.0	0.0	0.025992
WNW	0.000192	0.002176	0.011568	0.000802	0.0	0.0	0.014738
NW	0.000023	0.000687	0.003551	0.000687	0.0	0.0	0.004908
NNW	0.000122	0.000115	0.001489	0.000115	0.0	0.0	0.001840
TOTAL	0.006414	0.035506	0.107204	0.011110	0.000229	0.000115	

RELATIVE FREQUENCY OF OCCURRENCE OF C STABILITY = 0.160577

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH C STABILITY = 0.001374

Table 2.6-3. (Continued, Page 3 of 6)

RELATIVE FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION, CRYSTAL RIVER, FLORIDA (CON'T)

DIRECTION	SPEED (MIS)						TOTAL
	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	
N	0.000762	0.005841	0.011453	0.003436	0.000115	0.000229	0.021836
NNE	0.000512	0.001374	0.006132	0.001489	0.0	0.000229	0.011737
NE	0.000441	0.002978	0.016264	0.006528	0.000115	0.000229	0.026555
NNE	0.000600	0.004352	0.019585	0.006987	0.0	0.000115	0.031639
E	0.001527	0.007788	0.013401	0.004581	0.0	0.000115	0.027411
ESE	0.000930	0.003551	0.008132	0.001603	0.0	0.000115	0.014331
SE	0.000344	0.003665	0.006987	0.001947	0.0	0.000229	0.013172
SSE	0.000556	0.002863	0.006185	0.005154	0.000456	0.0	0.015216
S	0.000196	0.002634	0.009850	0.013973	0.001947	0.000344	0.028944
SSW	0.000276	0.001374	0.006643	0.014660	0.002634	0.001374	0.026963
SW	0.000145	0.000916	0.003894	0.009621	0.000229	0.000229	0.015034
WSW	0.000414	0.002062	0.006872	0.003780	0.0	0.000115	0.013242
W	0.000768	0.006070	0.010423	0.004696	0.000115	0.000229	0.022301
WNW	0.000421	0.002291	0.012141	0.006987	0.002062	0.000456	0.024359
NW	0.000283	0.001603	0.006299	0.007674	0.002978	0.000229	0.019067
NNW	0.000529	0.001947	0.003092	0.004238	0.000229	0.0	0.010035
TOTAL	0.008705	0.051311	0.149352	0.097354	0.010881	0.004238	

RELATIVE FREQUENCY OF OCCURRENCE OF 0 STABILITY = 0.321642

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH 0 STABILITY = 0.001718

Table 2.6-3 (Continued, Page 4 of 6).

RELATIVE FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION, CRYSTAL RIVER, FLORIDA (CON'T)

DIRECTION	SPEED (KTS)						TOTAL
	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	
N	0.008921	0.031841	0.024854	0.003436	0.000115	0.000229	0.069395
NNE	0.005896	0.017982	0.019700	0.001489	0.0	0.000229	0.045296
NE	0.007548	0.017295	0.037453	0.006758	0.000115	0.000229	0.069397
ENE	0.011446	0.045356	0.057382	0.007788	0.0	0.000115	0.122086
E	0.031213	0.072500	0.032757	0.005956	0.0	0.000115	0.142540
ESE	0.014317	0.028977	0.018096	0.001716	0.0	0.000115	0.063223
SE	0.006810	0.030695	0.012370	0.002291	0.0	0.000229	0.052395
SSE	0.003236	0.015577	0.012484	0.005154	0.000458	0.0	0.036910
S	0.002874	0.013286	0.018326	0.014660	0.002062	0.000344	0.051551
SSW	0.001896	0.008476	0.017409	0.018837	0.002749	0.001374	0.042740
SW	0.002264	0.008590	0.015691	0.011912	0.000229	0.000344	0.039029
WSW	0.002609	0.012828	0.023480	0.005040	0.0	0.000115	0.044070
W	0.006986	0.034017	0.047188	0.004925	0.000115	0.000229	0.093460
WNW	0.002778	0.013744	0.031955	0.007788	0.002062	0.000458	0.058785
NW	0.001932	0.009163	0.014431	0.008361	0.002478	0.000229	0.037094
NNW	0.004037	0.010194	0.007216	0.004352	0.000229	0.0	0.026027
TOTAL	0.114763	0.370518	0.390791	0.108464	0.011110	0.004352	

TOTAL RELATIVE FREQUENCY OF OBSERVATIONS = 1.000000

Table 2.6-3 (Continued, Page 5 of 6).

RELATIVE FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION, CRYSTAL RIVER, FLORIDA (CON'T)

DIRECTION	SPEED(KTS)						TOTAL
	0 - 3	4- 6,	7 - 10	11 - 16	17 - 21	GREATER THAN 21	
N	0.000903	0.001718	0.001031	0.0	0.0	0.0	0.003652
NNE	0.000880	0.001145	0.001145	0.0	0.0	0.0	0.003170
NE	0.001013	0.001489	0.001031	0.0	0.0	0.0	0.003532
ENE	0.000692	0.002405	0.002634	0.0	0.0	0.0	0.005732
E	0.002410	0.003665	0.002062	0.0	0.0	0.0	0.008137
ESE	0.001356	0.001145	0.001489	0.0	0.0	0.0	0.003991
SE	0.001246	0.001374	0.000687	0.0	0.0	0.0	0.003308
SSE	0.000770	0.001374	0.000573	0.0	0.0	0.0	0.002717
S	0.000724	0.003207	0.001374	0.0	0.0	0.0	0.005306
SSW	0.000491	0.003321	0.003436	0.0	0.0	0.0	0.007248
SW	0.000761	0.004123	0.004236	0.0	0.0	0.0	0.009122
WSW	0.000656	0.004467	0.006070	0.0	0.0	0.0	0.011193
W	0.001526	0.008361	0.011797	0.0	0.0	0.0	0.021684
WNW	0.000220	0.002520	0.003207	0.0	0.0	0.0	0.005947
NW	0.000156	0.000916	0.001145	0.0	0.0	0.0	0.002217
NNW	0.000170	0.001260	0.000115	0.0	0.0	0.0	0.001544
TOTAL	0.013973	0.042492	0.042034	0.0	0.0	0.0	

RELATIVE FREQUENCY OF OCCURRENCE OF S STABILITY = 0.098504

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH S STABILITY = 0.002176

Table 2.6-3 (Continued, Page 6 of 6)

RELATIVE FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION, CRYSTAL RIVER, FLORIDA (CON'T)

DIRECTION	SPEED (KTS)						TOTAL
	0 - 3	4 - 6,	7 - 10	11 - 16	17 - 21	GREATER THAN 21	
N	0.006882	0.022220	0.009277	0.0	0.0	0.0	0.038379
NNE	0.004424	0.013401	0.008017	0.0	0.0	0.0	0.025842
NE	0.005893	0.011568	0.013401	0.0	0.0	0.0	0.030861
ENE	0.004676	0.034704	0.023250	0.0	0.0	0.0	0.067630
E	0.025470	0.055893	0.005269	0.0	0.0	0.0	0.086632
ESE	0.010870	0.021991	0.003092	0.0	0.0	0.0	0.035953
SE	0.004668	0.023021	0.002176	0.0	0.0	0.0	0.030065
SSE	0.001562	0.008017	0.002520	0.0	0.0	0.0	0.012099
S	0.001670	0.005727	0.002062	0.0	0.0	0.0	0.009458
SSW	0.000896	0.002863	0.001489	0.0	0.0	0.0	0.005248
SW	0.000828	0.001718	0.001947	0.0	0.0	0.0	0.004493
WSW	0.000949	0.003780	0.002749	0.0	0.0	0.0	0.007478
W	0.003266	0.012255	0.005956	0.0	0.0	0.0	0.021477
WNW	0.001845	0.006643	0.005040	0.0	0.0	0.0	0.013527
NW	0.001434	0.005841	0.003436	0.0	0.0	0.0	0.010711
NNW	0.003192	0.006872	0.002520	0.0	0.0	0.0	0.012584
TOTAL	0.083724	0.236513	0.092200	0.0	0.0	0.0	

RELATIVE FREQUENCY OF OCCURRENCE OF E STABILITY = 0.412438

Table 2.6-4 Frequency of Occurrence of Pasquill's Stability Classes,
Crystal River Site, 1975.

Pasquill's Stability Class (%)					
Month	"A"	"B"	"C"	"D"	"E"
January	0.1	5.5	12.1	43.1	39.2
February	0.1	6.4	11.6	46.3	35.6
March	0.0	4.1	15.5	51.3	29.2
April	0.8	10.3	18.3	28.5	42.1
May	0.9	15.7	20.6	19.5	43.3
June	1.5	17.2	20.8	18.2	42.2
July	0.4	11.3	21.2	36.3	30.8
August	2.2	18.0	15.3	18.8	45.7
September	1.4	14.4	9.7	33.1	41.4
October	0.4	7.9	17.5	25.9	48.3
November	0.0	3.5	15.7	31.4	49.4
December	0.0	3.5	13.8	35.5	47.2
Annual	0.7	9.9	16.1	32.2	41.2

Source: Florida Power Corporation, 1975.

2.6.4 SEVERE STORMS

Thunderstorms are the most frequent severe storms affecting the site and these storms occur on an average of 80 days per year. Nearly 60 percent of these occur from June through August, triggered by moisture and heat convection within a tropical air mass, a nearby frontal system (squalls), or frequently a combination of both.

Tropical cyclones have invaded the 80-kilometer (50-mile) coastal strip from the site northward along the Gulf very infrequently over the last 30 years. However, from statistics compiled by Simpson and Lawrence (1971), the chance in any given year that a tropical cyclone will enter this strip is one in five. There is only a 6 percent chance that this storm will be of hurricane strength [33 meters per second (108 feet per second)] and it is very unlikely that its winds will exceed 56 mps, the speed of a great hurricane. Tropical cyclones will approach Crystal River only from early June through late October.

Statistics compiled by the Pantz (1969) show that less than 12 tornadoes (or waterspouts) were spotted within the 1° latitude by 1° longitude square encompassing the site during the years 1955-67. This averages out to less than one per year. The tornado recurrence interval for a specific point on the site is estimated by the methodology of Thom (1963) to be roughly every 1250 years. The most common tornado month is June.

2.6.5 MIXING DEPTHS

The monthly and average mixing depths for Tampa as estimated by Holzworth are listed in Table 2.6-5. The highest afternoon mixing depths occur in the spring, while the lowest morning depths occur in winter. At the site, the mean high humidity and low-level cloudiness prevent mean mixing depth subsidence below 300 meters (1,000 feet).

Table 2.6-5 Mean Diurnal Mixing Depth* (Meters), Tampa International Airport, Tampa, Florida

Month	Morning	Afternoon
January	391	1010
February	477	1106
March	498	1330
April	514	1533
May	497	1701
June	617	1528
July	703	1424
August	649	1423
September	590	1473
October	375	1510
November	307	1239
December	326	1048
ANNUAL	495	1360

* 5-year averaged data 1960-1964

Source: National Climatic Center, 1973.

2.7

ECOLOGY

2.7.1 INTRODUCTION

To highlight the important ecological and environmental elements, the baseline terrestrial environment analysis of the proposed plant site is divided into "Ecosystem Analysis" and "Important Species Analysis."

"Ecosystem Analysis" describes the structure of the system in terms of community types, species present, and current environmental conditions, as well as the ecological forces and trends which determine present and future ecological conditions. The natural values and values to man of these on-site ecosystem components are also discussed. Information developed from an ecological survey in the summer of 1977 is used to describe the predicted future environment without the proposed plants.

The four categories of important species defined by the Florida Department of Environmental Regulation (1977) are grouped in this section under the following three headings: Commercially and Recreationally Important Species; Rare and Endangered Species; and Functionally Critical Species (those species which affect the well-being of species in the above two categories or which are critical to the structure and function of the ecological system).

The community descriptions have been derived largely from the Wildlife Study of the Cross-Florida Barge Canal Restudy Report (Florida Game and Freshwater Fish Commission, 1976). One exception is the ruderal category, which is defined as "an area where the natural vegetative cover has been disturbed or artificially maintained by man in an early stage of succession." Ruderal areas include old fields, pastures and cropland, ditches, transmission corridors, and similar areas. Small swamps and marshes occur within these areas, but they differ from the natural

state in that they are maintained as early successional shrub swamps, or are composed largely of invader species from other systems.

The second exception is the coastal hydric hammock. The categories in the Wildlife Study do not adequately describe the strip of coastal wetland forest which runs along the Gulf Coast of Florida. The hydroperiod and soil moisture content are greater than those of true mesic hammock or coastal hammock, yet the soil type and species content are not those of hydric hammock. Wharton, et al. (1976), classify the coastal hydric hammock system as "Hydric Hammock--North Florida Type."

Conversion tables are included for the vegetation maps to translate into the corresponding Level III categories of the Florida Land Use and Cover Classification System. This standardized, state-wide system developed by the Florida Division of State Planning (1976) is now used by a wide variety of state and local agencies. It is included to provide means of standardization for all review agencies.

The plant site area discussed in this section includes all of Florida Power's property north of the existing access road and discharge canal from Highway 19 to the outer edge of the emergent vegetation (salt marsh) in the Gulf of Mexico.

2.7.2 TERRESTRIAL ECOSYSTEM ANALYSIS

ECOLOGICAL STRUCTURE

Plant Communities

The plant site area (Figure 2.7-1) can be divided into five general geographic areas based upon combinations of elevation, substrates, and physiognomy (general appearance) of the dominant vegetation. The shore area on the west is composed of salt marsh with numerous interspersed islands supporting the coastal hammock type of vegetation. Between this salt marsh and the proposed plant location is a belt of coastal hydric hammock which is an extension of the wetland forest belt south of the existing units.

The southern half of the proposed plant location is dominated by plant communities which are variants of the southern mixed hardwoods association (Monk, 1965). Mesic hammock forest occupies about half of this area wherever the limestone shelf lies at the land surface. Where the surface layer of limestone is missing, the hydric hammock variant occurs in the resulting low areas.

The northern section of the proposed plant location, in which the limestone is overlain by a somewhat deeper sand layer, is primarily slash pine flatwoods with lesser amounts of evergreen oak scrub and small, seasonal freshwater marsh. The transmission corridor contains primarily ruderal vegetation (61 percent), but some areas of natural vegetation also occur.

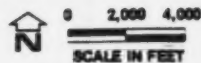
The land outside of the property to the north and east has been largely cleared and planted in slash pine plantations and improved pasture (Figure 2.7-2). The area to the south of the site is similar to the area west of the proposed plant location and is primarily salt marsh and coastal hydric hammock.

Vegetative composition of the site generally is typical of the region (Tables 2.7-1 and 2.7-2). Plant communities which occur inland in the



SYMBOL	CLASSIFICATION	FLORIDA LAND USE AND CLASSIFICATION SYSTEM Number	FLORIDA LAND USE AND CLASSIFICATION SYSTEM Name	SYMBOL	CLASSIFICATION	FLORIDA LAND USE AND CLASSIFICATION SYSTEM Number	FLORIDA LAND USE AND CLASSIFICATION SYSTEM Name
SM	Saltwater Marsh	642	Saltwater Marsh	HH	Hydric Hammock	621	Freshwater Swamp
FM	Freshwater Marsh	641	Freshwater Marsh	CH	Coastal Hammock	431	Mixed Forest
SPF	Slash Pine Flatwoods	411	Pine Flatwoods	CHH	Coastal Hydric Hammock	422	Other Hardwood Forest
LPF	Longleaf Pine Flatwoods	411	Longleaf Pine Flatwoods			631	Mixed Wetland Forest
EOS	Evergreen Oak Scrub	421	Xeric Oak Hardwood Forest	PP	Pine Plantation	441	Coniferous Planted Forest
LPS	Longleaf Pine Sandhill	412	Longleaf Pine Xeric Oak Forest	CD	Cypress Dome	611	Cypress Wetland Coniferous Forest
DOS	Deciduous Oak Sandhill	421	Xeric Oak Hardwood Forest	MS	Mixed Swamp	621	Freshwater Swamp
XH	Xeric Hammock	422	Other Hardwood Forest	RI	Ruderal		Several Types
MH	Misc Hammock	422	Other Hardwood Forest	IJ	Urban/Industrial	100	Urban or Built up
		414	Other Coniferous Forest				

Figure 2.7-2
VEGETATION MAP OF THE VICINITY OF THE
PROPOSED PLANT SITE



SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Table 2.7-1 Plant Community Composition of Proposed Plant and Region in Acres and Percent of Vegetated Area

Location	Community													Total Wetlands 600	Total Areas
	Slash Evergreen				Coastal				Salt-		Fresh-		Plantation		
	Pine 4111	Oak 421	Mesic Hammock 422/414	Hydric Hammock 621	Coastal Hammock 431	Coastal Hydric Hammock 422/631	water Marsh 642	water Marsh 641	Ruderal		Early Succession				
									Swamp 621	Marsh 641					
Primary Site Area	175.6	15.1	64.9	81.2	33.9	128.8	277.5	24.4	12.5	16.4	68.9	12.0	540.8	911.2	
Acres	71.06	6.11	26.3	32.9	13.7	52.12	112.3	9.87	5.06	6.64	27.9	4.86	218.9	368.8	
Hectares	19.3	1.7	7.1	8.9	3.7	14.1	30.4	2.7	1.4	1.8	7.7	1.3	59.3	--	
Percentage															
Access Area and Transmission Corridor*	24.0	--	125.7	4.6	--	--	--	20.5	3.42	14.5	223.1	--	73.8	446.6	
Acres	9.71	--	50.87	1.9	--	--	--	8.31	13.8	5.87	90.29	--	29.9	180.7	
Hectares	5.4	--	28.1	1.0	--	--	--	4.6	7.7	3.2	50.0	--	16.5	--	
Percentage															
Total for Entire Site	199.6	15.1	190.6	85.8	33.9	128.8	277.5	44.9	46.7	30.9	292.0	12.0	614.6	1,357.8	
Acres	80.78	6.11	77.13	34.7	13.7	52.12	112.3	18.2	18.9	12.5	110.2	4.86	248.7	549.48	
Hectares	14.7	1.1	14.0	6.3	2.5	9.5	20.4	3.3	3.4	2.3	21.5	0.9	45.3	--	
Percentage															

*The area east of the northern extension of the plant site and west of Highway 19-98.
If Florida Land Use and Cover Classification System category designation.

**Total area includes only vegetated areas. Does not include 55.93 hectares (138.2 acres) of disturbed industrial area
76.16 hectares (188.2 acres) of water.

Source: Environmental Science and Engineering, Inc., 1978.

Table 2.7-2 Plant Community Composition Within an 8-Kilometer (5-Mile)
Radius of Plant Site

	Land Cover Category	Hectares	Acres	Percent of Land Area
Slash and Longleaf Pine Flatwoods	411	2,630	6,490	20.2
Evergreen Oak Scrub and Sandhills	411/412	247	610	1.9
Mesic Hammock	422/414	1,050	2,600	8.1
Hydric Hammock	621	43	105	0.3
Coastal Hammock	431	318	785	2.4
Coastal Hydric Hammock	422/631	1,390	3,440	10.7
Salt Water Marsh	642	3,020	7,450	23.2
Fresh Water Marsh	641	280	700	2.2
Mixed Swamp	621	249	615	1.9
Cypress Dome	611	40	100	0.3
All Ruderal Areas	(mainly 213)	950	2,345	7.4
Pine Plantation	441	1,760	4,350	13.6
Xeric Hammock	422	71	175	0.5
Urban	100's	632	1,560	4.9
Water*	500's	300	750	2.3
Total Wetlands†	600's	5,046	12,460	38.8
TOTAL AREA*		12,980	32,075	

*Exclusive of rivers and coastal waters.

†Including wetlands within ruderal areas.

Source: Environmental Science and Engineering, Inc., 1977.

vicinity but not on-site are mixed swamp, cypress dome, deciduous oak and longleaf pine sandhills, xeric hammock, and longleaf pine flatwoods. Only those communities found on-site will be described further. Table 2.7-3 lists the characteristic species of each of the communities.

Evergreen Oak Scrub

Evergreen oak scrub occupies the driest areas on the site, generally in small patches [less than 1.2 hectares (3 acres)] where the depth of surficial sands generally is greater than 1 meter (3 feet). Characteristic species are shrubby evergreen oaks, under 6 meters (20 feet) tall. Sand-live oak and myrtle oak are the principal species on-site. Saw palmetto forms a very dense shrub layer, and persimmon is common. No quantitative data was gathered on this community type.

Pine Flatwoods

Upland areas with sands from 0.3 to 1 meter (1 to 3 feet) deep or with a fractured limestone substrate support slash pine flatwoods. Results of the summer survey are shown in Table 2.7-4. The canopy is overwhelmingly slash pine (importance value 251 out of a total 300), with cabbage palm and southern red cedar as associates (see Chapter 6 for an explanation of the derivation of importance values).

The on-site pine flatwoods were cut-over in the early 1960's. A few pines remained which are currently about 25 to 38 centimeters (10 to 15 inches) in diameter at breast height (DBH), and the area was naturally reseeded by these individual trees. Today, young pines have formed a dense canopy (852 trees per acre) about 4.5 meters (15 feet) tall. This dense canopy and the dense saw palmettos have largely restricted the associated herbaceous and shrubby vegetation to a limited number of common flatwoods species such as wax-myrtle, persimmon, and winged sumac.

Table 2.7-3. Typical Species Composition of Plant Communities Found on the Proposed Plant Site

I. Evergreen Oak Scrub

A. Definition. Stands of evergreen oaks less than 6 m (18 ft) tall with little or no shiny lyonia or gallberry, and no pine trees. No tree overstory or understory layer. Well drained, sandy soils.

B. <u>Characteristic species</u>		<u>Growth Form*</u>
Sand-live oak	<u>Quercus geminata</u>	S
Myrtle oak	<u>Quercus myrtifolia</u>	S
Saw palmetto	<u>Serenoa repens</u>	S
Chapmans oak	<u>Quercus chapmanii</u>	S
Rusty lyonia	<u>Lyonia ferruginea</u>	S

II. Slash Pine Flatwoods

A. Definition. Stands with slash pine 1 to 20 m (3 to 80 ft) tall, few hardwood trees, and understory cover of at least 25 percent. Poorly drained, acidic sands. Often maintained by periodic fires.

B. <u>Characteristic species.</u>		
Slash pine	<u>Pinus elliottii</u>	T
Loblolly bay	<u>Gordonia lasianthus</u>	T
Saw palmetto	<u>Serenoa repens</u>	S
Gallberry	<u>Ilex glabra</u>	S
Shiny lyonia	<u>Lyonia lucida</u>	S
Rusty lyonia	<u>Lyonia ferruginea</u>	S
Shiny blueberry	<u>Vaccinium myrsinites</u>	S
Wax myrtle	<u>Myrica cerifera</u>	S
Sandweed	<u>Hypericum fasciculatum</u>	S
Wire grass	<u>Aristida stricta</u>	H

III. Mesic Hammock

A. Definition. Southern mixed hardwood forest, with pignut hickory, oaks, sweetgum, and cabbage palm to 10 to 20 m (40 to 70 ft) tall. Few or no ashes or black gum. Stands lacking poison ivy or sweetgum are classified as xeric hammock. Soils never flooded, rarely soggy. Climax community with fire rare.

B. <u>Characteristic species.</u>		
Live oak	<u>Quercus virginiana</u>	T
Water oak	<u>Quercus nigra</u>	T
Cabbage palm	<u>Sabal palmetto</u>	T
Sweetgum	<u>Liquidambar styraciflua</u>	T
Pignut hickory	<u>Carya glabra</u>	T

Table 2.7-3. Typical Species Composition of Plant Communities Found on the Proposed Plant Site (Continued, Page 2 of 4)

Saw palmetto	<u>Serenoa repens</u>	S
Sparkleberry	<u>Vaccinium arboreum</u>	S
Grape	<u>Vitis rotundifolia</u>	V
Poison ivy	<u>Rhus radicans</u>	V
Partridge berry	<u>Mitchella repens</u>	H
Yellow jessamine	<u>Gelsemium sempervirens</u>	V

IV. Hydric Hammock

A. Definition. Southern mixed hardwood forest, with sweetgum and cabbage palm, but with no pignut hickory, few ashes. Poorly drained to flooded soils. Intergrades with mesic hammock, mixed swamp, and bayhead.

B. Characteristic species.

Cabbage palm	<u>Sabal palmetto</u>	T
Sweet gum	<u>Liquidambar styraciflua</u>	T
Diamond-leaf oak	<u>Quercus laurifolia</u>	T
Red maple	<u>Acer rubrum</u>	T
Carolina ash	<u>Fraxinus carolinianum</u>	T
Winged elm	<u>Ulmus alata</u>	T
Swamp chestnut oak	<u>Quercus michauxii</u>	T
Poison ivy	<u>Rhus radicans</u>	V
Greenbriar	<u>Smilax spp.</u>	V
Wax myrtle	<u>Myrica cerifera</u>	S

V. Coastal Hammock

A. Definition. Mixed hardwood/conifer forests with southern red-cedar, pignut hickory, yaupon, and buckthorn. A variant of mesic hammock found only on elevated limestone islands in Gulf coast salt marshes. The canopy height of the gnarled trees is limited to about 10 m (30 ft) by salt spray, winds, hurricanes, and storm tides.

B. Characteristic species.

Cabbage palm	<u>Sabal palmetto</u>	T
Southern red-cedar	<u>Juniperus silicicola</u>	T
Pignut hickory	<u>Carya glabra</u>	T
Paper mulberry	<u>Broussonetia papyrifera</u>	T
Yaupon	<u>Ilex vomitoria</u>	S
Carolina holly	<u>Ilex ambigua</u>	S
Snowberry	<u>Symphoricarpos albus</u>	S
False willow	<u>Baccharis angustifolia</u>	S
Florida privet	<u>Forestiera segregata</u>	S
Myrsine	<u>Rapanea guianensis</u>	S
Wild coffee	<u>Psychotria ligustrifolia</u>	H

Table 2.7-3. Typical Species Composition of Plant Communities Found on the Proposed Plant Site (Continued, Page 3 of 4)

VI. Coastal Hydric Hammock

A. Definition. Wetland forests with an evergreen oak appearance, dominated by southern red-cedar, cabbage palm, diamond-leaf oak sweetgum, and live oak. Soils are poorly drained, "hummocky" sands or peat over limestone, subject to constant seepage (Wharton, et al., 1976).

B. Characteristic species.

Cabbage palm	<u>Sabal palmetto</u>	T
Southern red-cedar	<u>Juniperus silicicola</u>	T
Sweetgum	<u>Liquidambar styraciflua</u>	T
Diamond-leaf oak	<u>Quercus laurifolia</u>	T
Live oak	<u>Quercus virginiana</u>	T
Sweet bay	<u>Magnolia virginiana</u>	T
Southern magnolia	<u>Magnolia grandiflora</u>	T
Ironwood	<u>Carpinus caroliniana</u>	S
Wax myrtle	<u>Myrica cerifera</u>	S

VII. Freshwater Marsh

A. Definition. Generally treeless, seasonally or permanently flooded areas with emergent vegetation dominated by maidencane or sawgrass. Soils range from thin marl over limestone to deep mucks or peats.

B. Characteristic species.

Sawgrass	<u>Cladium jamaicense</u>	H
Maidencane	<u>Panicum hemitomon</u>	H
Creeping rush	<u>Juncus repens</u>	H
Smartweed	<u>Polygonum hydropiperoides</u>	H

VIII. Saltwater Marsh

A. Definition. Treeless saltwater or brackish tidal areas with emergent vegetation dominated by grasses and rushes in essentially monospecific bands. Soils deep organic mucks.

B. Characteristic species.

Smooth cordgrass	<u>Spartina alterniflora</u>	H
Black needlerush	<u>Juncus roemerianus</u>	H
Saltgrass	<u>Distichlis spicata</u>	H

Table 2.7-3. Typical Species Composition of Plant Communities Found on the Proposed Plant Site (Continued, Page 4 of 4)

IX. Pine Plantation

A. Definition. Planted pine stands with combined understory and shrub layer cover of 25 percent or less. Occurs on varied, well to poorly drained soils which have been cleared and grubbed of native vegetation.

B. Characteristic species.

Slash pine	<u>Pinus elliottii</u>	T
Loblolly pine	<u>Pinus taeda</u>	T
Saw palmetto	<u>Serenoa repens</u>	S
Gallberry	<u>Ilex glabra</u>	S

X. Ruderal

A. Definition. Any of several types which are artificially maintained in an early successional stage. Varied, often disturbed soils of mixed drainage. Maintained by mechanical or chemical means, burning, or grazing. Shrub layer lacking to dense; no overstory or understory.

B. Characteristic species.

Pasture grasses	<u>Paspalum, Cynodon, etc.</u>	H
Dog fennel	<u>Eupatorium capillifolium</u>	H
Coastal-plain willow	<u>Salix caroliniana</u>	S
Blackberry	<u>Rubus spp.</u>	H
Grape	<u>Vitis spp.</u>	V
Morning glory	<u>Ipomoea spp.</u>	V

* Characteristic growth form as follows: T=tree; S=shrub; H=herb; V=vine.

Sources: Florida Game and Fresh Water Fish Commission, 1976.
Environmental Science and Engineering, Inc., 1977.

Table 2.7-4 Plant Species Found in Pine Flatwoods Section of Proposed Site During Summer, 1977, Survey

		Importance Value	Density/ Acre	Frequency %	Total Basal Area (ft ²)	Mean DBH (inches)
<u>Overstory and Understory Strata</u>						
Slash pine	<u>Pinus elliotii</u>	231.0	763	100	6.0	3
Wax myrtle	<u>Myrica cerifera</u>	22.0	44	21	0.0	2
Cabbage palm	<u>Sabal palmetto</u>	10.7	9	4	0.4	9
Southern red-cedar	<u>Juniperus silicicola</u>	8.2	18	8	0.0	2
Persimmon	<u>Diospyros virginiana</u>	4.1	9	4	0.0	1
Winged sumac	<u>Rhus copallina</u>	4.1	9	4	0.0	1
Total		300.1	852	—	6.4	—

		Frequency %	Cover %
<u>Shrub Strata</u>			
Saw palmetto	<u>Serenoa repens</u>	100	21
Wax myrtle	<u>Myrica cerifera</u>	100	10
Gallberry	<u>Ilex glabra</u>	50	4
Slash pine	<u>Pinus elliotii</u>	25	4
Winged sumac	<u>Rhus copallina</u>	25	3
Persimmon	<u>Diospyros virginiana</u>	25	1
Bracken fern	<u>Pteridium aquilinum</u>	25	0
Total		—	43

<u>Herbaceous Strata</u>			
Wax-myrtle	<u>Myrica cerifera</u>	75	2
Greenbriar	<u>Smilax spp.</u>	75	0
Paspalum	<u>Paspalum sp.</u>	50	8
Saw palmetto	<u>Serenoa repens</u>	50	2
Gallberry	<u>Ilex glabra</u>	50	2
Red maple	<u>Acer rubrum</u>	50	2
Wire grass	<u>Aristida stricta</u>	25	1
Persimmon	<u>Diospyros virginiana</u>	25	1
Winged sumac	<u>Rhus copallina</u>	25	1
Black-eyed Susan	<u>Rudbeckia hirta</u>	25	1
Poison ivy	<u>Rhus radicans</u>	25	0
Panic grass	<u>Panicum sp.</u>	25	0
Panic grass	<u>Panicum sp.</u>	25	0
Dactyloctenium	<u>Dactyloctenium aegyptium</u>	25	0
Fleabane	<u>Pluchea rosea</u>	25	0
Blackberry	<u>Rubus sp.</u>	25	0
Oahoon	<u>Ilex cassine</u>	25	0
Southern red-cedar	<u>Juniperus silicicola</u>	25	0
Eryngo	<u>Eryngium integri folium</u>	25	0
Rattlesnake master	<u>Eryngium yuccifolium</u>	25	0
Beak rush	<u>Rhynchospora sp.</u>	25	0
Rabbit tobacco	<u>Pterocaulon undulatum</u>	25	0
Aster	<u>Aster sp.</u>	25	0
Musky mint	<u>Hypoxis alata</u>	25	0
Morning glory	<u>Ipomoea sagittata</u>	25	0
Horseweed	<u>Erigeron canadensis</u>	25	0
Total		—	21

Source: Environmental Science and Engineering, Inc., 1977.

Hammocks

The southern portion of the proposed site contains both upland (mesic hammock) and wetland (hydric hammock) elements of the southern mixed hardwood forest as described by Monk (1965), and by Quarterman and Keever (1962). Diamond-leaf oak, cabbage palm, and sweetgum are common throughout both elements, whereas slash pine and live oak occur in mesic hammock, and red maple, black gum, and red bay occur in hydric hammock.

The results of sampling along four transects (Table 2.7-5) show that dominance is shared fairly equally by diamond-leaf oak, cabbage palm, and slash pine. Basswood, water oak, and blackgum are subdominants. This heterogeneous species composition indicates a large amount of interspersed hydric hammock, mesic hammock, and pine flatwoods vegetation. Delineation of wetland and upland areas is based largely upon the presence of indicator species such as red maple, black gum, and red bay, or slash pine and live oak (Florida Department of State Planning, 1976), as well as by the presence or absence of standing water.

Although tree density (408 trees per acre) in this area is much less than in the flatwoods, the total basal area of the tree stems and the number of tree species is much greater (33.5 square feet and 22 species). Presumably because of the interspersed habitats, the number of herb species (53) found in this area was greater than in any of the other communities.

Freshwater Marshes

Freshwater marshes on the site generally are isolated "pothole" marshes less than 1 hectare (3 acres) in size. Sawgrass is dominant (Table 2.7-6) with a fairly low number of associated species, including isolated black gum and red maple saplings. Water in these marshes is very clear with almost no occurrence of algae or floating mats.

Table 2.7-5 Plant Species Found in Mesic Hammock/Hydric Hammock Section of Proposed Site During Summer, 1977, Survey

		Importance	Density/	Frequency	Total Basal	Mean DBH
		Value	Acre	%	Area (ft ²)	(inches)
<u>Overstory and Understory Strata</u>						
Slash pine	<u>Pinus elliotii</u>	53.7	106	38	4.4	4
Diamond-leaf oak	<u>Quercus laurifolia</u>	51.5	58	35	8.3	8
Cabbage palm	<u>Sabal palmetto</u>	51.5	48	38	8.6	10
Live oak	<u>Quercus virginiana</u>	19.2	19	6	4.2	10
Sweetgum	<u>Liquidambar styraciflua</u>	19.2	32	16	1.8	5
Black gum	<u>Nyssa biflora</u>	15.8	23	13	1.8	13
Basswood	<u>Tilia americana</u>	14.0	16	13	1.8	7
Water oak	<u>Quercus nigra</u>	10.1	13	13	0.7	6
Wax myrtle	<u>Myrica cerifera</u>	10.0	19	13	0.1	2
Carolina laurel-cherry	<u>Prunus caroliniana</u>	10.0	13	13	0.6	5
Red bay	<u>Persea borbonia</u>	8.5	13	9	0.6	3
Green ash	<u>Fraxinus pennsylvanica</u>	5.3	6	3	0.9	8
Southern red-cedar	<u>Juniperus silicicola</u>	4.8	6	6	0.3	5
Red maple	<u>Acer rubrum</u>	4.5	6	6	0.1	4
Myrtle-leaf holly	<u>Ilex myrtifolia</u>	4.2	6	6	0.1	2
Persimmon	<u>Diospyros virginiana</u>	3.1	6	3	0.1	3
Chapmans oak	<u>Quercus chapmanii</u>	2.8	3	3	0.3	7
Tough bumelia	<u>Bumelia tenax</u>	2.8	3	3	0.3	7
Southern magnolia	<u>Magnolia grandiflora</u>	2.6	3	3	0.2	6
Large gallberry	<u>Ilex coriacea</u>	2.2	3	3	0.1	3
Ironwood	<u>Carpinus caroliniana</u>	2.1	3	3	0.0	2
Stiffcornel dogwood	<u>Cornus stricta</u>	2.1	3	3	0.0	1
Total		300.0	408	—	33.5	—

		Frequency	Cover
		%	%
<u>Shrub Strata</u>			
Wax myrtle	<u>Myrica cerifera</u>	38	4
Saw palmetto	<u>Serenoa repens</u>	25	3
Persimmon	<u>Diospyros virginiana</u>	12	2
Stiffcornel dogwood	<u>Cornus stricta</u>	12	2
Myrtle-leafed oak	<u>Quercus myrtifolia</u>	12	1
Dahoon	<u>Ilex cassine</u>	12	1
Winged sumac	<u>Rhus copallina</u>	12	0
Beautyberry	<u>Callicarpa americanus</u>	12	0
Greenbriar	<u>Smilax spp.</u>	12	0
Total		—	13

Table 2.7-5 Plant Species Found in Mesic Hammock/Hydric Hammock Section of Proposed Site During Summer, 1977, Survey (Continued, page 2 of 2)

		Frequency %	Cover %
St.-John's-wort	<u>Hypericum</u> sp.	50	0
Greenbriar	<u>Smilax</u> spp.	50	0
Wax-myrtle	<u>Myrica cerifera</u>	38	2
Saw palmetto	<u>Serenoa repens</u>	38	1
Panic grass	<u>Panicum</u> sp.	50	1
Palpalum	<u>Paspalum</u> sp.	25	6
Sawgrass	<u>Cladium jamaicense</u>	25	3
Broomsedge	<u>Andropogon virginicus</u>	25	1
Gallberry	<u>Ilex glabra</u>	25	1
Dahoon	<u>Ilex cassine</u>	25	1
Black-eyed susan	<u>Rudbeckia hirta</u>	25	0
Persimmon	<u>Diospyros virginiana</u>	25	0
Grape	<u>Vitis rotundifolia</u>	25	0
Widespread maiden fern	<u>Thelypteris normalis</u>	25	0
Red maple	<u>Acer rubrum</u>	25	0
Passion flower	<u>Passiflora incarnata</u>	25	0
Yellow jessamine	<u>Gelsemium sempervirens</u>	25	0
Myrtle-leaved oak	<u>Quercus myrtifolia</u>	12	3
Rattlesnake master	<u>Eryngium yuccaefolia</u>	12	1
Sedge	<u>Carex</u> sp.	12	1
Live oak	<u>Quercus virginiana</u>	12	1
Red bud	<u>Cercis canadensis</u>	12	1
Winged sumac	<u>Rhus copallina</u>	12	0
Partridge pea	<u>Cassia fasciculata</u>	12	0
Hoary pea	<u>Tephrosia spicata</u>	12	0
Goldenrod	<u>Solidago</u> sp.	12	0
Aster	<u>Aster</u> sp.	12	0
Horseweed	<u>Erigeron canadensis</u>	12	0
Rabbit tobacco	<u>Pterocaulon undulatum</u>	12	0
Dayflower	<u>Commelina</u> sp.	12	0
Buttonbush	<u>Cephalanthus occidentalis</u>	12	0
Resurrection fern	<u>Polypodium polypodioides</u>	12	0
Lizards tail	<u>Saururus cernuus</u>	12	0
Diamond-leaved oak	<u>Quercus laurifolia</u>	12	0
Water oak	<u>Quercus nigra</u>	12	0
Poison ivy	<u>Rhus radicans</u>	12	0
Basswood	<u>Tilia americana</u>	12	0
Bedstraw	<u>Galium</u> sp.	12	0
Partridge berry	<u>Mitchella repens</u>	12	0
Sweetgum	<u>Liquidambar styraciflua</u>	12	0
Blackberry	<u>Rubus</u> sp.	12	0
Unknown		12	0
Coontie	<u>Zamia integrifolia</u>	12	0
Unknown		12	0
Arrowhead	<u>Sagittaria</u> sp.	12	0
Spanish moss	<u>Tillandsia usneoides</u>	—	—
Wild pine	<u>Tillandsia fasciculata</u>	—	a*
Needle-leaved wild pine	<u>Tillandsia setacea</u>	—	a
Wild pine	<u>Tillandsia polystachia</u>	—	c
Green-fly orchid	<u>Epidendrum conopseum</u>	—	r
Total		—	23

*Epiphytic species (living on branches of other plants) listed only as a=abundant; c=common; o=occasional; r=rare.

Source: Environmental Science and Engineering, Inc., 1977.

Table 2.7-6 Plant Species Found in Freshwater Marsh on Proposed Site During Summer 1977 Survey

	Large* Marshes			Small† Marshes		
	Frequency %	Cover %	Density m ²	Frequency %	Cover %	Density m ²
Sawgrass	100	15	9.6	43	3	2.4
Red maple	71	3	0.8	--	--	--
Fleabane	71	1	5.0	57	0	4.5
Creeping rush	71	1	3.1	71	2	3.8
Centella	44	7	5.7	57	0	2.9
Maidencane	44	2	0.9	--	--	--
Black gum	44	2	0.1	--	--	--
Beak rush	44	1	5.3	57	4	9.9
Soft rush	44	1	0.6	71	0	2.4
Hedge-hyssop	44	0	18.0	14	0	1.1
Musky mint	44	0	0.7	14	0	0.1
Smartweed	44	0	1.6	28	0	1.2
Panic grass	28	0	0.7	14	0	0.1
Morning glory	28	0	0.6	28	0	0.6
St. John's wort	14	1	0.1	--	--	--
Water-hyssop	14	0	1.1	--	--	--
Winged loosestrife	14	0	0.3	--	--	--
Sand cordgrass	14	0	0.1	--	--	--
Slash pine	14	0	0.1	--	--	--
Unknown	14	0	0.1	--	--	--
Unknown	14	0	0.1	--	--	--
Milkweed	14	0	0.1	14	0	0.1
Climbing hempweed	14	0	0.1	--	--	--
Lizards Tail	14	0	0.1	--	--	--
Arrowhead	14	0	0.1	14	3	0.1
Water-dropwort	--	--	--	28	3	3.6
Spike rush	--	--	--	28	3	1.7
<u>Cladium jamaicense</u>						
<u>Acer rubrum</u>						
<u>Pluchea rosea</u>						
<u>Juncus repens</u>						
<u>Centella asiatica</u>						
<u>Panicum hemitomon</u>						
<u>Nyssa biflora</u>						
<u>Rhynchospora sp.</u>						
<u>Juncus effusus</u>						
<u>Gratiola virginiana</u>						
<u>Hyptis alata</u>						
<u>Polygonum hydropiperoides</u>						
<u>Panicum sp.</u>						
<u>Ipomoea sagittata</u>						
<u>Hypericum fasciculatum</u>						
<u>Bacopa carolinianum</u>						
<u>Lythrum lanceolatum</u>						
<u>Spartina bakeri</u>						
<u>Pinus elliotii</u>						
<u>Asclepias lanceolata</u>						
<u>Mikania scandens</u>						
<u>Saururus cernuus</u>						
<u>Sagittaria lancifolia</u>						
<u>Oxypolis filiformis</u>						
<u>Eleocharis sp.</u>						

Table 2.7-6 Plant Species Found in Freshwater Marsh on Proposed Site During Summer, 1977, Survey
(Continued, Page 2 of 2)

	Large* Marshes			Small† Marshes		
	Frequency %	Cover %	Density/ m ²	Frequency %	Cover %	Density/ m ²
Broomsedge						
Aster	--	-	--	14	0	1.7
Unknown	--	-	--	14	0	0.4
Wax myrtle	--	-	--	14	0	2.7
Greenbrier	--	-	--	14	2	0.1
Naiad	--	-	--	14	0	0.1
Milkweed	--	-	--	14	0	1.4
	--	-	--	14	0	0.2
TOTAL	--	34	--	--	20	--

* Greater than or equal to 0.4 hectare (1 acre)

† Less than 0.4 hectare (1 acre)

Source: Environmental Science and Engineering, Inc., 1977.

Pine Plantations

Pines in the plantations have been planted about 1.5 meters (5 feet) apart in rows 3.6 meters (12 feet) apart to give a density of 580 trees per acre. These young (10 years old) trees have reached heights of 2 to 3.6 meters (7 to 12 feet) but have not yet formed a solid canopy. The ground cover of the open areas is composed of species common to pine flatwoods and ruderal areas (Table 2.7-7).

Ruderal Areas

The transmission corridors are dominated by such herbaceous and shrubby species as dogfennel, fleabane, broomsedge, milkweeds, partridge pea, and winged sumac (Table 2.7-8), most of which are common, old-field, early successional species. Low areas within the corridors consist either of fresh marsh or shrub swamp. These marshes are similar to wet prairies and have a mix of marsh species (i.e., sawgrass, smartweed, soft rush) and species of nearby upland areas. The swamps are maintained in a low, shrubby state with Carolina willow, buttonbush, red maple seedlings, and invading upland shrubs.

Salt Marsh

On the west, the site is bordered by a strip of salt marsh about 1.6 kilometers (1 mile) in width. The outer edge is composed of an almost pure band of smooth cordgrass, but the bulk of the marsh is dominated by black needlerush (Young, 1974).

Along the inner margin, the marsh grades into the coastal hydric hammock. In this edge zone, salt grass is the dominant species. Several channels extend as far as 180 meters (600 feet) into the hammock from the salt marsh area. These channels are bordered by species of both fresh and salt marsh areas. Among these are salt grass, saltwort, glasswort, creeping rush, arrowhead, and sawgrass.

Table 2.7-7 Plant Species Found in The Ground Cover of Pine Plantations
of Proposed Site During Summer 1977 Survey

Common Name	Scientific Name	% Cover
Broomsedge	<u>Andropogon virginicus</u>	20
Panic grass	<u>Panicum sp.</u>	1
Dallis grass	<u>Paspalum dilatatum</u>	1
Soft rush	<u>Juncus effusus</u>	1
Sedge	<u>Scirpus sp.</u>	1
Sweetgum	<u>Liquidambar styraciflua</u>	1
Gallberry	<u>Ilex glabra</u>	1
Wax myrtle	<u>Myrica cerifera</u>	1
Winged sumac	<u>Rhus copallina</u>	1
Partridge pea	<u>Cassia fasciculata</u>	1
Fleabane	<u>Pluchea rosea</u>	1
Horseweed	<u>Erigeron canadensis</u>	t*
Panic grass	<u>Panicum sp.</u>	t
Deers tongue	<u>Trilisa odoratissima</u>	t
Milkpea	<u>Galactia elliottii</u>	t
St. John's wort	<u>Hypericum perforatorium</u>	t
Aster	<u>Aster sp.</u>	t
Musky mint	<u>Hyptis alata</u>	t

* Trace.

Source: Environmental Science and Engineering, Inc., 1977.

Table 2.7-8. Plant Species Found in Ruderal Areas of Proposed Site During Summer 1977 Survey

	Early Successional		Fresh Marsh		Swamp	
	Frequency %	Cover %	Frequency %	Cover %	Frequency %	Cover %
<u>Baccharis angustifolia</u>	100	1.8	20	1.0	50	2.5
<u>Juncus effusus</u>	80	9.0	60	2.3	--	--
<u>Andropogon virginicus</u>	80	5.2	40	1.2	100	5.5
<u>Rhynchospora sp.</u>	60	2.0	20	0.0	--	--
<u>Panicum sp.</u>	60	0.6	20	0.0	--	--
<u>Centella asiatica</u>	60	0.2	40	31.7	--	--
Unknown	60	0.0	40	0.4	--	--
<u>Ipomoea arvensis</u>	60	0.0	20	0.0	50	0.0
<u>Rhus copallina</u>	40	5.0	--	--	50	5.0
<u>Salix caroliniana</u>	40	1.2	20	1.0	50	7.5
Unknown	40	1.2	--	--	--	--
<u>Cladium jamaicense</u>	40	0.4	60	14.0	--	--
<u>Setaria geniculata</u>	40	0.2	--	--	--	--
<u>Scirpus sp.</u>	40	0.0	--	--	--	--
<u>Vernonica noveboracensis</u>	40	0.0	60	0.6	50	1.5
<u>Hypericum perforatum</u>	40	0.0	--	--	--	--
<u>Scirpus cyperinus</u>	20	2.0	20	0.3	--	--
<u>Rudbeckia hirta</u>	20	0.2	--	--	50	0.0
<u>Euphorbia supina</u>	20	0.2	--	--	--	--
<u>Trilisa odoratissima</u>	20	0.0	--	--	--	--
<u>Erigeron canadensis</u>	20	0.0	--	--	--	--
<u>Solidago sp.</u>	20	0.0	--	--	--	--
<u>Hydrocotyle umbellata</u>	20	0.0	20	0.0	--	--
<u>Ipomoea purpurea</u>	20	0.0	--	--	--	--
<u>Eupatorium compositifolium</u>	20	0.0	20	0.0	--	--

Table 2.7-8. Plant Species Found in Ruderal Areas of Proposed Site During Summer 1977 Survey
(Continued, Page 2 of 3)

	Early Successional		Fresh Marsh 641		Swamp 621	
	Frequency %	Cover %	Frequency %	Cover %	Frequency %	Cover %
Fleabane	20	0.0	20	0.0	50	0.0
Rosinweed	20	0.0	--	--	--	--
Wild sensitive plant	20	0.0	--	--	--	--
Milkpea	20	0.0	--	--	--	--
Blackberry	20	0.0	--	--	--	--
Greenbrier	20	0.0	--	--	--	--
Beautyberry	20	0.0	--	--	--	--
Saw palmetto	20	0.0	--	--	--	--
Southern red-cedar	20	0.0	--	--	--	--
Red maple	20	0.0	20	0.2	--	--
Fimbristylis	20	0.0	20	1.0	--	--
Sand cordgrass	20	0.0	20	1.0	--	--
Walter millet	20	0.0	20	1.0	50	0.5
Saltgrass	--	--	40	0.4	--	--
Sedge	--	--	20	0.0	--	--
Panic grass	--	--	20	0.0	50	0.0
Cattail	--	--	20	1.0	--	--
Smartweed	--	--	40	0.0	--	--
Musky mint	--	--	40	1.1	100	5.0
Creeping rush	--	--	40	0.0	--	--
Prickly lettuce	--	--	20	0.0	--	--
Water hyssop	--	--	20	0.0	--	--
Carolina ash	--	--	60	0.4	--	--
Late boneset	--	--	20	0.2	--	--
Grape	--	--	--	--	100	5.5
<u>Pluchea rosea</u>	20	0.0	20	0.0	50	0.0
<u>Silphium integrifolium</u>	20	0.0	--	--	--	--
<u>Cassia nictitans</u>	20	0.0	--	--	--	--
<u>Galactia elliottii</u>	20	0.0	--	--	--	--
<u>Rubus sp.</u>	20	0.0	--	--	--	--
<u>Smilax spp.</u>	20	0.0	--	--	--	--
<u>Callicarpa americana</u>	20	0.0	--	--	--	--
<u>Serenoa repens</u>	20	0.0	20	0.2	--	--
<u>Juniperus silicicola</u>	20	0.0	20	1.0	--	--
<u>Acer rubrum</u>	20	0.0	20	1.0	--	--
<u>Fimbristylis autumnalis</u>	--	--	60	5.0	50	0.0
<u>Spartina bakeri</u>	--	--	20	0.0	--	--
<u>Echinochloa walteri</u>	--	--	20	1.0	50	0.5
<u>Distichlis spicata</u>	--	--	40	0.4	--	--
<u>Scirpus sp.</u>	--	--	20	0.0	--	--
<u>Panicum sp.</u>	--	--	20	0.0	50	0.0
<u>Typha latifolia</u>	--	--	20	1.0	--	--
<u>Polygonum hydropiperoides</u>	--	--	40	0.0	--	--
<u>Hyptis alata</u>	--	--	40	1.1	100	5.0
<u>Juncus repens</u>	--	--	40	0.0	--	--
<u>Lactuca scariola</u>	--	--	20	0.0	--	--
<u>Bacopa caroliniana</u>	--	--	20	0.0	--	--
<u>Fraxinus caroliniana</u>	--	--	60	0.4	--	--
<u>Eupatorium serotinum</u>	--	--	20	0.2	--	--
<u>Vitis rotundifolia</u>	--	--	--	--	100	5.5

Table 2.7-8. Plant Species Found in Ruderal Areas of Proposed Site During Summer 1977 Survey
(Continued, Page 3 of 3)

	Early Successional		Fresh Marsh		Swamp	
	Frequency %	Cover %	Frequency %	Cover %	Frequency %	Cover %
Lizards tail	--	--	--	--	50	1.5
Rose-mallow	--	--	--	--	50	5.0
Widespread maiden fern	--	--	--	--	50	0.5
Wild bean	--	--	--	--	50	0.0
Hedge hyssop	--	--	--	--	50	0.0
Pepper-vine	--	--	--	--	50	0.0
Aster	--	--	--	--	50	10.0
TOTAL	--	35.2	--	64.8	--	45.0

Source: Environmental Science and Engineering, Inc., 1977.

Coastal Hydric Hammock

Table 2.7-9 lists the vegetative composition of the coastal hydric hammock as found during the Summer 1977 survey. Cabbage palm, live oak, and southern red-cedar comprise 71 percent of the dominance as measured by the importance value index. Live oak is represented by a few large individuals (45 centimeters or 18 inches mean DBH) which furnish much of the canopy cover, while diamond-leaf oak is represented by numerous small individuals (10 centimeters or 4 inches mean DBH).

On the seaward edge of this hammock community, southern red-cedar and cabbage palm are dominant in a somewhat open canopy. There is a general increase in the number of broadleaf tree species and in canopy cover with increasing distance inland. Although density/cover of all three strata are not significantly different from those of the other areas studied, the basal area per acre value of 6.2 square meters (67 square feet) was almost double the value of the other hammock and ten times that of the flatwoods. This higher value is a result of the presence of larger trees and is to some degree an indication of an older system.

Coastal Hammock

Within the salt marsh itself are several islands containing a flora similar to the coastal portion of the coastal hydric hammock. This portion is dominated by the cabbage palm and the southern red cedar. The substrate is somewhat drier and the land surface higher than in the coastal hydric hammock. Associated species include yaupon, poison ivy, pigment hickory, and live oak. The canopy height of the gnarled and twisted trees is only about 9 meters (30 feet) (U.S. Army Corps of Engineers, 1976).

Table 2.7-9. Plant Species Found in Coastal Hydric Hammock Section of Proposed Site During Summer 1977 Survey

		Importance Value	Density/ Acre	Frequency %	Total Basal Area (ft ²)	Mean DBH (inches)
<u>Overstory and Understory Strata</u>						
Cabbage palm	Sabal palmetto	121.7	141	81	36.7	11
Southern red-cedar	Juniperus silicicola	53.5	93	53	6.4	5
Live oak	Quercus virginiana	38.1	21	22	16.5	18
Diamond-leaf oak	Quercus laurifolia	13.3	21	19	0.6	4
Southern magnolia	Magnolia grandiflora	10.9	12	13	2.1	8
Wax myrtle	Myrica cerifera	9.9	15	16	0.1	2
Sweetgum	Liquidambar styraciflua	6.9	15	6	0.4	4
American elm	Ulmus americana	6.6	9	9	0.5	5
Red bay	Persea borbonia	6.1	9	9	0.2	3
Basswood	Tilia americana	5.8	6	6	1.3	10
Red maple	Acer rubrum	5.4	6	6	1.0	10
Green ash	Fraxinus pennsylvatica	5.0	6	6	0.7	8
Myrtle-leaf holly	Ilex myrtifolia	4.7	9	6	0.0	1
Coastal-plain willow	Salix caroliniana	3.8	9	3	0.2	3
Ironwood	Carpinus caroliniana	2.5	3	3	0.4	8
Water oak	Quercus nigra	2.0	3	3	0.0	2
Carolina laurel-cherry	Prunus caroliniana	2.0	3	3	0.0	2
Carolina ash	Fraxinus caroliniana	2.0	3	3	0.0	1
TOTAL		300.2	384	--	67.1	--

Table 2.7-9. Plant Species Found in Coastal Hydric Hammock Section of Proposed Site During Summer 1977 Survey
(Continued, Page 2 of 3)

Shrub Strata	Frequency %	Cover %
Southern red-cedar	40	2
Diamond-leaf oak	40	2
Wax myrtle	40	1
Poison ivy	20	4
Live oak	20	3
Cabbage palm	20	3
Spoonleaf yucca	20	2
Myrtle-leaved holly	20	1
Carolina ash	20	1
Sweet gum	20	1
Saw palmetto	20	0
Virginia creeper	20	0
TOTAL	--	20
Herbaceous Strata		
Saw palmetto	40	0
Wax myrtle	60	2
Green briar	60	0
Sawgrass	40	4
Southern red-cedar	40	1
Beautyberry	40	1
Red ba	40	0
Diamond-leaved oak	40	0
Juniperus silicicola		
Quercus laurifolia		
Myrica cerifera		
Rhus radicans		
Quercus virginiana		
Sabal palmetto		
Yucca filamentosa		
Ilex myrtifolia		
Fraxinus caroliniana		
Liquidambar styraciflua		
Serenoa repens		
Parthenocissus quinquefolia		
Serenoa repens		
Myrica cerifera		
Smilax sp.		
Cladium jamaicense		
Juniperus silicicola		
Callicarpa americana		
Persea borbonia		
Quercus laurifolia		

Table 2.7-9. Plant Species Found in Coastal Hydric Hammock Section of Proposed Site During Summer 1977 Survey
(Continued, Page 3 of 3)

	Frequency %	Cover %
<u>Herbaceous Strata (continued)</u>		
Swamp lily	40	0
Spoonleaf yucca	20	1
Grass	20	1
Swamp chestnut oak	20	1
Pokeweed	20	1
Live oak	20	1
Sensitive fern	20	1
Passion flower	20	0
Poison ivy	20	0
Yellow jessamine	20	0
Sweet bay	20	0
Widespread maiden fern	20	0
Ressurrection fern	--	c*
Spanish moss	--	o*
Wild pine	--	r*
Needle-leaved wild pine	--	o*
Green-fly orchid	--	r*
TOTAL	--	14

* a-abundant, c-common, o-occasional, r-rare.

Source: Environmental Science and Engineering, Inc., 1977.

Animal Communities

The aquatic and terrestrial systems of the region support a variety of fauna related to the diversity of habitats. Sixteen species of mammals, 60 species of birds, 20 species of reptiles, and 11 species of amphibians were observed in the area of concern during the 1977 field survey. The preferred habitat and relative abundance of these species and of other expected animals are listed in Table 2.7-10. Qualitative small mammal trapping data are presented in Table 2.7-11. Of the 422 expected species, 50 are considered rare and endangered on at least one state listing and 13 are important as furbearers, game, or marketable food resources.

The quality and quantity of habitat are among the most important factors influencing the abundance and diversity of animal populations in a given area. Prime wildlife habitat must have not only an adequate acreage but also sufficient habitat interspersed so that wildlife can meet all their needs in a small area. Because of the interspersed and extensive variety of plant communities present at the site, this area is considered good habitat for a number of species (Table 2.7-10). Larger mammals, such as white-tailed deer, black bear, and feral swine, are found in the vicinity and may utilize the various ecosystems. These species, along with many bird species, are more mobile and may utilize a variety of different habitats depending on season, food supply, available cover, breeding/nesting requirements, and climate. Other species are more restricted and their ranging habits show a preference for a specific area or habitat. Some of these species occurring in the region include rufous-sided towhee (sandpine scrub and pine flatwoods); hispid cotton rat (pine flatwoods); broad-head skink (mixed swamp); and Gulf hammock rat snake (mesic and coastal hammock). With an increase in the variety of plant communities, there is a greater number of microhabitats. These microhabitats often are utilized by a diverse fauna (e.g., narrow-mouth toad, slimy salamander, and Florida red-bellied snake).

Table 2.7-10 Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur on or in the Vicinity of the Proposed Plant Site, Citrus County (Page one of sixteen)

Order	Family	Species	Common Name	Species Observed	Pine/Oak Scrub	Mesic & Xeric Hammock	Coastal & Hydric Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Marsupialia	Didelphidae	<u>Didelphis marsupialis</u>	Opossum	*	X	X	X	X	X	X	X	X		X
Insectivora	Soricidae	<u>Sorex longirostris</u>	Southeastern shrew		X	X	X							
		<u>Blarina brevicauda</u>	Shorttail shrew	*	X	X	X	X	X		X	X		X
		<u>Cryptotis parva</u>	Least shrew		X	X	X							
Talpidae		<u>Scalopus aquaticus</u>	Eastern mole	*	X	X			X	X				
Chiroptera	Vespertilionidae	<u>Pipistrellus subflavus</u>	Eastern pipistrel								X			X
		<u>Eptesicus fuscus</u>	Big brown bat			X	X				X			X
		<u>Lasiurus borealis</u>	Red bat			X	X				X			X
		<u>Lasiurus seminolus</u>	Seminole bat			X	X				X			X
		<u>Lasiurus intermedius</u>	Yellow bat		X	X					X			
		<u>Lasiurus cinereus</u>	Hoary bat			X	X				X			
		<u>Nycticeius humeralis</u>	Evening bat		X	X	X				X			
		<u>Plecotus rafinesquii</u>	Big-eared bat				X							
Molossidae		<u>Tadarida brasiliensis</u>	Mexican freetail bat											X
Edentata	Dasypodidae	<u>Dasypus novemcinctus</u>	Nine-banded armadillo	*	X	X			X	X	X	X		X
Lagomorpha	Leporidae	<u>Sylvilagus floridanus</u>	Eastern cottontail	*	X	X			X					X
Rodentia		<u>Sylvilagus palustris</u>	Marsh rabbit	*	X								X	
Sciuridae		<u>Sciurus carolinensis</u>	Gray squirrel	*	X	X	X	X	X	X	X			X
		<u>Sciurus niger</u>	Fox squirrel		X	X			X					X
		<u>Glaucomys volans</u>	Southern flying squirrel		X	X	X							
Geomys		<u>Geomys pinetis</u>	Southeastern pocket gopher		X					X				X

Table 2.7-10 Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur on or in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page two of sixteen)

Order	Family	Species	Common Name	Species Observed	Pine/Oak Scrub	Maritime & Xeric Hammock	Coastal & Hydrophytic Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Cricetidae	Oryzomys	<u>palustris</u>	Rice rat			X	X	X				X	X	
		<u>leucogaster</u>	Harvest mouse		X	X	X	X	X			X	X	X
		<u>floridanus</u>	Old-field mouse		X	X	X	X	X	X		X	X	X
		<u>gambelii</u>	Cotton mouse	*	X	X	X	X	X	X		X	X	X
		<u>nuttalli</u>	Golden mouse		X	X	X	X	X	X		X	X	X
		<u>floridanus</u>	Florida mouse	*	X	X	X	X	X	X		X	X	X
		<u>sigmodon</u>	Cotton rat	*	X	X	X	X	X	X		X	X	X
		<u>neotoma</u>	Eastern woodrat			X	X	X	X	X		X	X	X
		<u>pinetorum</u>	Pine vole			X	X	X	X	X		X	X	X
		<u>alleni</u>	Round-tailed muskrat									X		
		<u>norvegicus</u>	Norway rat											X
		<u>rattus</u>	Black rat											X
		<u>musculus</u>	House mouse											X
		<u>canis</u>	Gray fox	*	X	X	X	X	X	X	X			X
		<u>familiaris</u>	Feral dog		X	X	X	X	X	X	X			X
Ursidae	Ursus	<u>americanus</u>	Black bear		X									
		<u>litor</u>	Raccoon	*	X	X	X	X	X	X	X	X	X	X
		<u>frenata</u>	Longtail weasel		X	X	X	X	X	X	X			
		<u>vison</u>	Mink		X	X	X	X	X	X	X			
		<u>mephitis</u>	Striped skunk		X									
		<u>canadensis</u>	River otter	*										
		<u>canadensis</u>												
		<u>canadensis</u>												
		<u>canadensis</u>												
		<u>canadensis</u>												
Canidae	Canis	<u>cinereus</u>	Gray fox	*	X	X	X	X	X	X	X			X
		<u>familiaris</u>	Feral dog		X	X	X	X	X	X	X			X
		<u>americanus</u>	Black bear		X									
		<u>litor</u>	Raccoon	*	X	X	X	X	X	X	X	X	X	X
		<u>frenata</u>	Longtail weasel		X	X	X	X	X	X	X			
		<u>vison</u>	Mink		X	X	X	X	X	X	X			
		<u>mephitis</u>	Striped skunk		X									
		<u>canadensis</u>	River otter	*										
		<u>canadensis</u>												
		<u>canadensis</u>												

Table 2.7-10 Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur on or in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page three of sixteen)

Order	Family	Species	Common Name	Species Observed	Pine/Oak Sand-hill Scrub	Mesic & Xeric Hammock	Coastal & Hydro Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Felidae	<i>Felis concolor</i> <i>Lynx rufus</i> <i>Felis catus</i> <i>Artiodactyla</i>	Florida panther Bobcat Feral cat		*	X	X	X		X		X			
				*	X	X	X		X					
Suidae	<i>Sus scrofa</i> <i>Cervidae</i>	Feral swine White-tailed deer							X	X	X	X		X
									X	X	X	X		X
				*	X	X	X		X	X	X	X		X
Cervidae	<i>Odontocervus virginianus</i>								X	X	X	X		X
									X	X	X	X		X

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page five of sixteen)

Order	Species	Common Name	Species Observed	Pine/Oak Sand-hill Scrub	Maritime & Xeric Hammock	Coastal & Hydric Hammock	Cypress Dome	Pine Plantations	Pine Plantations	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Anseriformes (continued)													
	<u>Anas crecca carolinensis</u>	Green-winged teal	*										
	<u>Anas discors</u>	Blue-winged teal	*										
	<u>Anas penelope</u>	European widgeon											
	<u>Anas americana</u>	American widgeon											
	<u>Anas clypeata</u>	Northern shoveler											
	<u>Aix sponsa</u>	Wood duck											
	<u>Aythya americana</u>	Redhead											
	<u>Aythya collaris</u>	Ring-necked duck											
	<u>Aythya valisineria</u>	Canvasback											
	<u>Aythya marila</u>	Greater scaup											
	<u>Aythya affinis</u>	Lesser scaup											
	<u>Bucephala clangula</u>	Common goldeneye											
	<u>Bucephala albeola</u>	Bufflehead											
	<u>Oxyura jamaicensis</u>	Ruddy duck											
	<u>Lophodytes cucullatus</u>	Hooded merganser											
	<u>Mergus mergamus</u>	Common merganser											
	<u>Mergus serrator</u>	Red-breasted merganser											
Falconiformes													
	<u>Cathartes aura</u>	Turkey vulture	*										
	<u>Coragyps atratus</u>	Black vulture	*										
	<u>Elanoides forficatus</u>	Swallow-tailed kite	*										
	<u>Ictinia mississippiensis</u>	Mississippi kite											
	<u>Accipiter striatus</u>	Sharp-shinned hawk											
	<u>Accipiter cooperii</u>	Cooper's hawk											
	<u>Buteo jamaicensis</u>	Red-tailed hawk	*										
	<u>Buteo lineatus</u>	Red-shouldered hawk	*										
	<u>Buteo platypterus</u>	Broad-winged hawk											
	<u>Buteo brachyurus</u>	Short-tailed hawk											
	<u>Melanerpes formicivorus</u>	Bald eagle	*										
	<u>Circus cyaneus</u>	Marsh hawk											
	<u>Pandion haliaetus</u>	Osprey	*										
	<u>Falco peregrinus</u>	Peregrine falcon											
	<u>Falco columbarius</u>	Merlin											
	<u>Falco sparverius</u>	American kestrel											
Galliformes													
	<u>Colinus virginianus</u>	Bobwhite	*										
	<u>Meleagris gallopavo</u>	Turkey											

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page six of sixteen)

Order	Species	Common Name	Species Observed	Pine/Oak Sandhill Scrub	Heath & Xeric Hammock	Coastal & Hydr	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Gruiformes	<i>Grus canadensis</i>	Sandhill crane											X
	<i>Aramus guarauna</i>	Limpkin								X			
	<i>Kallus elegans</i>	King rail									X		
	<i>Kallus longirostris</i>	Clapper rail	*									X	
	<i>Kallus limicola</i>	Virginia rail									X		
	<i>Porzana carolina</i>	Sora									X		
	<i>Coturnicops noveboracensis</i>	Yellow rail									X		
	<i>Laterallus jamaicensis</i>	Black rail									X		
	<i>Porphyrio martinica</i>	Purple gallinule									X		
	<i>Gallinula chloropus</i>	Common gallinule									X		
	<i>Fulica americana</i>	American coot									X		
Charadriiformes	<i>Haematopus palliatus</i>	American oystercatcher											
	<i>Haematopus mexicanus</i>	Black-necked stilt											
	<i>Charadrius semipalmatus</i>	Semipalmated plover											
	<i>Charadrius melodus</i>	Piping plover											
	<i>Charadrius wilsonia</i>	Wilson's plover											
	<i>Charadrius vociferus</i>	Killdeer	*	X									
	<i>Charadrius alexandrinus</i>	Snowy plover											
	<i>Pluvialis squatarola</i>	Black-bellied plover											
	<i>Arenaria interpres</i>	Ruddy turnstone											
	<i>Philohela minor</i>	American woodcock				X							
	<i>Capella gallinago</i>	Common snipe								X			
	<i>Numenius americanus</i>	Long-billed curlew											
	<i>Numenius phaeopus</i>	Whimbrel											
	<i>Bartramia longicauda</i>	Upland sandpiper											
	<i>Actitis macularia</i>	Spotted sandpiper											
	<i>Tringa solitaria</i>	Solitary sandpiper											
	<i>Tringa melanoleucus</i>	Greater yellowlegs								X			
	<i>Tringa flavipes</i>	Lesser yellowlegs											
	<i>Catoptrophorus semipalmatus</i>	Willet											
Columbiformes	<i>Calidris canutus</i>	Red knot											
	<i>Calidris melanotos</i>	Pectoral sandpiper											
	<i>Calidris fuscicollis</i>	White-rumped sandpiper											
	<i>Calidris minutilla</i>	Least sandpiper											

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page seven of sixteen)

Order	Species	Common Name	Species Observed	Pine/Oak Sandhill Scrub	Mesic & Xeric Hammock	Coastal & Hydro Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Fasture & Developed (Ruderal)
Gruiformes (continued)	<i>Calidris alpina</i>	Dunlin											
	<i>Calidris pusillus</i>	Semipalmated sandpiper											
	<i>Calidris mauri</i>	Western sandpiper											
	<i>Calidris alba</i>	Sanderling											
	<i>Limnodromus griseus</i>	Short-billed dowitcher											
	<i>Limnodromus scolopaceus</i>	Long-billed dowitcher											
	<i>Limosa fedoa</i>	Marbled godwit											
	<i>Phalaropus fulicarius</i>	Red phalarope											
	<i>Lobipes lobatus</i>	Northern phalarope											
	<i>Larus marinus</i>	Great black-backed gull	*										
	<i>Larus argentatus</i>	Herring gull											
	<i>Larus delawarensis</i>	King-billed gull											
	<i>Larus atricilla</i>	Laughing gull											
	<i>Larus philadelphia</i>	Bonaparte's gull											
	<i>Gelochelidon nilotica</i>	Gull-billed tern											
	<i>Sterna forsteri</i>	Forster's tern	*										
	<i>Sterna hirundo</i>	Common tern											
	<i>Sterna fuscata</i>	Sooty tern											
	<i>Sterna dougallii</i>	Roseate tern	*										
	<i>Sterna albifrons</i>	Least tern											
	<i>Sterna maxima</i>	Royal tern											
	<i>Sterna caspia</i>	Caspian tern											
	<i>Sterna sandvicensis</i>	Sandwich tern											
	<i>Chlidonias niger</i>	Black tern											
	<i>Rynchops nigra</i>	Black skimmer	*										
	Columbiformes												
	<i>Columba livia</i>	Rock dove	*										
	<i>Zenaidura macroura</i>	White-wing dove											
	<i>Zenaidura macroura</i>	Mourning dove	*										
	<i>Columbina passerina</i>	Ground dove	*										
	Cuculiformes												
	<i>Coccyzus americanus</i>	Yellow-billed cuckoo	*										
	<i>Coccyzus erythrophthalmus</i>	Black-billed cuckoo											

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page eight of sixteen)

Order	Species	Common Name	Observed	Pine/Oak Sand- hill Scrub	Marine & Xeric Hammock	Coastal & Hy- dric Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Strigiformes													
	<i>Tyto alba</i>	Barn owl			X	X							X
	<i>Otus asio</i>	Screech owl			X	X							X
	<i>Bubo virginianus</i>	Great horned owl		X	X					X			
	<i>Athene cunicularia</i>	Burrowing owl		X	X								X
	<i>Strix varia</i>	Barred owl	*	X	X	X	X			X			
	<i>Asio flammeus</i>	Short-eared owl			X							X	
Caprimulgiformes													
	<i>Caprimulgus carolinensis</i>	Chuck-will's widow		X	X	X							
	<i>Caprimulgus vociferus</i>	Whip-poor-will		X	X	X							
	<i>Chordeiles minor</i>	Common nighthawk	*	X	X	X	X			X			X
Apodiformes													
	<i>Chaetura pelagica</i>	Chimney swift		X						X			X
	<i>Archilochus colubris</i>	Ruby-throated hummingbird			X								
Coraciiformes													
	<i>Megasceryle alcyon</i>	Belted kingfisher	*		X	X	X			X	X	X	
Piciformes													
	<i>Colaptes auratus</i>	Common flicker	*	X	X	X			X	X			X
	<i>Dryocopus pileatus</i>	Pileated woodpecker	*	X	X	X	X		X	X			X
	<i>Centurus carolinus</i>	Red-bellied woodpecker	*	X	X	X	X		X	X			X
	<i>Melanerpes erythrocephalus</i>	Red-headed woodpecker	*	X	X	X			X	X			X
	<i>Sphyrapicus varius</i>	Yellow-bellied sapsucker	*	X	X	X			X	X			X
	<i>Picoides villosus</i>	Hairy woodpecker	*	X	X	X			X	X			X
	<i>Dendrocopos pubescens</i>	Downy woodpecker		X	X	X			X	X			X
	<i>Dendrocopos borealis</i>	Red-cockaded woodpecker		X	X	X			X	X			X
Passeriformes													
	<i>Tyrannus tyrannus</i>	Eastern kingbird							X				X
	<i>Tyrannus dominicensis</i>	Gray kingbird			X							X	
	<i>Tyrannus verticalis</i>	Western kingbird			X								X
	<i>Myiarchus cinerascens</i>	Great crested flycatcher	*	X	X	X			X	X			X
	<i>Sayornis phoebe</i>	Eastern phoebe		X	X	X			X	X			X
	<i>Empidonax virens</i>	Acadian flycatcher		X	X	X			X	X			X
	<i>Contopus virens</i>	Eastern wood pewee			X				X	X			X
	<i>Iridoprocne bicolor</i>	Tree swallow	*	X					X	X			X
	<i>Riparia riparia</i>	Bank swallow							X	X			X
	<i>Stelgidopteryx ruficollis</i>	Rough-winged swallow		X									X

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page nine of sixteen)

Order	Species	Common Name	Species Observed	Pine/Oak Sand-hill Scrub	Mesic & Xeric Hammock	Coastal & Hydro Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Wetland Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Passeriformes (continued)													
	<i>Mirundo rustica</i>	Barn swallow		X									X
	<i>Petrochelidon pyrrhonota</i>	Cliff swallow										X	X
	<i>Progne subis</i>	Purple martin	*	X	X	X	X	X	X	X	X	X	X
	<i>Cyanocitta cristata</i>	Blue jay	*	X	X	X	X	X	X	X	X	X	X
	<i>Aphelocoma coerulescens</i>	Scrub-jay	*	X	X	X	X	X	X	X	X	X	X
	<i>Corvus brachyrhynchos</i>	Common crow	*	X	X	X	X	X	X	X	X	X	X
	<i>Corvus ossifragus</i>	Fish crow	*	X	X	X	X	X	X	X	X	X	X
	<i>Parus carolinensis</i>	Carolina chickadee	*	X	X	X	X	X	X	X	X	X	X
	<i>Parus bicolor</i>	Tufted titmouse	*	X	X	X	X	X	X	X	X	X	X
	<i>Sitta carolinensis</i>	White-breasted nuthatch		X	X	X	X	X	X	X	X	X	X
	<i>Sitta pusilla</i>	Brown-headed nuthatch			X								
	<i>Certhia familiaris</i>	Brown creeper			X								
	<i>Teumatodytes palustris</i>	Marsh wren			X								
	<i>Troglodytes aedon</i>	House wren		X	X	X	X	X	X	X	X	X	X
	<i>Troglodytes troglodytes</i>	Winter wren			X	X	X	X	X	X	X	X	X
	<i>Thryomanes bewickii</i>	Bewick's wren			X	X	X	X	X	X	X	X	X
	<i>Thryothorus ludovicianus</i>	Carolina wren	*	X	X	X	X	X	X	X	X	X	X
	<i>Cistothorus palustris</i>	Long-billed marsh wren											
	<i>Cistothorus platensis</i>	Short-billed marsh wren									X		
	<i>Mimus polyglottos</i>	Mockingbird	*	X	X	X	X	X	X	X	X	X	X
	<i>Dumetella carolinensis</i>	Gray catbird	*	X	X	X	X	X	X	X	X	X	X
	<i>Toxostoma rufum</i>	Brown thrasher	*	X	X	X	X	X	X	X	X	X	X
	<i>Turdus migratorius</i>	American robin	*	X	X	X	X	X	X	X	X	X	X
	<i>Catharus guttatus</i>	Hermit thrush	*	X	X	X	X	X	X	X	X	X	X
	<i>Catharus ustulatus</i>	Swainson's thrush			X	X	X	X	X	X	X	X	X
	<i>Catharus minimus</i>	Gray-cheeked thrush			X	X	X	X	X	X	X	X	X
	<i>Catharus fuscescens</i>	Veery			X	X	X	X	X	X	X	X	X
	<i>Hylocichla ustulata</i>	Wood thrush			X	X	X	X	X	X	X	X	X
	<i>Sialia sialis</i>	Eastern bluebird	*	X	X	X	X	X	X	X	X	X	X
	<i>Polioptila caerulea</i>	Blue-gray gnatcatcher		X	X	X	X	X	X	X	X	X	X
	<i>Regulus satrapa</i>	Golden-crowned kinglet		X	X	X	X	X	X	X	X	X	X
	<i>Regulus calendula</i>	Ruby-crowned kinglet		X	X	X	X	X	X	X	X	X	X
	<i>Anthus spinoletta</i>	Water pipit		X	X	X	X	X	X	X	X	X	X
	<i>Anthus spragueii</i>	Sprague's pipit											

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page ten of sixteen)

Order Species	Common Name	Species Observed	Pine/Oak Sand- hill Scrub	Mesic & Xeric Hammock	Coastal & Hy- dric Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Passeriformes (continued)												
<i>Icterus galbula</i>	Northern oriole											X
<i>Euphagus carolinus</i>	Busty blackbird											
<i>Quiscalus major</i>	Boat-tailed grackle	*	X	X	X		X				X	X
<i>Quiscalus quiscula</i>	Common grackle											X
<i>Molothrus ater</i>	Brown-headed cowbird											X
<i>Piranga olivacea</i>	Scarlet tanager			X								
<i>Piranga rubra</i>	Summer tanager	*	X	X	X		X					X
<i>Cardinalis cardinalis</i>	Cardinal	*	X	X	X		X					X
<i>Guiraca caerulea</i>	Blue grosbeak		X									X
<i>Passerina cyanea</i>	Indigo bunting											X
<i>Passerina ciris</i>	Painted bunting											X
<i>Carduelis pinus</i>	Pine siskin											X
<i>Carduelis tristis</i>	American goldfinch											X
<i>Loxia curvirostra</i>	Red crossbill		X	X	X		X	X				X
<i>Pipilo erythrophthalmus</i>	Rufous-sided towhee	*	X	X	X							X
<i>Passerculus sandwichensis sandwichensis</i>	Savannah sparrow											X
<i>Ammodramus saviannarum</i>	Grasshopper sparrow						X					X
<i>Ammodramus henslowii</i>	Henslow's sparrow											X
<i>Amospiza caudacuta</i>	Sharp-tailed sparrow										X	
<i>Amospiza lecontei</i>	LeConte's sparrow									X		
<i>Amospiza maritima</i>	Seaside sparrow											X
<i>Poocetes gramineus</i>	Vesper sparrow											
<i>Amophila aestivalis</i>	Bachman's sparrow		X				X					
<i>Junco hyemalis hyemalis</i>	Dark-eyed junco											X
<i>Spizella passerina</i>	Chipping sparrow		X				X					X
<i>Spizella pusilla</i>	Field sparrow											X
<i>Zonotrichia leucophrys</i>	White-crowned sparrow											X
<i>Zonotrichia albicollis</i>	White-throated sparrow		X		X		X					X
<i>Melospiza lincolni</i>	Lincoln's sparrow											X
<i>Melospiza georgiana</i>	Swamp sparrow				X		X				X	

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page eleven of sixteen)

Order	Species	Common Name	Species Observed	Pine/Oak Sand-hill Scrub	Maritime & Xeric Hammock	Coastal & Hydro Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Passeriformes (continued)	<i>Bombicilla cedrorum</i>	Cedar waxwing		X									X
	<i>Lanius ludovicianus</i>	Loggerhead shrike	*	X									X
	<i>Sturnus vulgaris</i>	Starling	*										X
	<i>Vireo griseus</i>	White-eyed vireo	*	X	X	X	X	X	X	X			X
	<i>Vireo flavifrons</i>	Yellow-throat vireo		X	X	X		X		X			X
	<i>Vireo altiloquus</i>	Black-whiskered vireo				X							
	<i>Vireo solitarius</i>	Solitary vireo		X	X	X		X		X			X
	<i>Vireo olivaceus</i>	Red-eyed vireo	*	X	X	X	X	X		X			
	<i>Vireo philadelphicus</i>	Philadelphia vireo				X							
	<i>Mniotilta varia</i>	Black and white warbler	*	X	X	X	X	X					
	<i>Protonotaria citrea</i>	Prothonotary warbler			X	X							
	<i>Limothlypis swainsonii</i>	Swainson's warbler			X	X							
	<i>Helminthophila swainsonii</i>	Worm-eating warbler			X	X							
	<i>Vermivora vermivora</i>	Golden-winged warbler			X	X							
	<i>Vermivora chrysopetra</i>	Blue-winged warbler											X
	<i>Vermivora pinus</i>	Bachman's warbler								X			
	<i>Vermivora bachmani</i>	Tennessee warbler								X			
	<i>Vermivora peregrina</i>	Orange-crowned warbler		X	X	X	X	X	X	X			X
	<i>Vermivora celata</i>	Northern parula	*	X	X	X							
	<i>Parula americana</i>	Yellow warbler											
	<i>Dendroica petechia</i>	Cape May warbler											
	<i>Dendroica trichas</i>	Black-throated blue warbler		X				X	X	X			X
	<i>Dendroica caerulescens</i>	Yellow-rumped warbler		X				X	X	X			
	<i>Dendroica coronata</i>	Blackburnian warbler		X				X	X	X			
	<i>Dendroica fusca</i>	Yellow-throated warbler		X				X	X	X			
	<i>Dendroica dominica</i>	Chestnut-sided warbler		X									
	<i>Dendroica pensilvanica</i>	Blackpoll warbler		X						X			
	<i>Dendroica striata</i>	Fine warbler		X				X	X	X			X
	<i>Dendroica pinus</i>	Kirtland's warbler		X	X								
	<i>Dendroica kirtlandii</i>	Prairie warbler		X				X	X				
	<i>Dendroica discolor</i>	Palm warbler		X	X	X		X	X				
	<i>Dendroica palmarum</i>	Greenbird		X	X								
	<i>Seiurus aurocapillus</i>	Northern waterthrush		X						X			X
	<i>Seiurus noveboracensis</i>												

Table 2.7-10 Preferred Habitat and Seasonal Occurrence of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page twelve of sixteen)

Order	Species	Common Name	Species Observed	Pine/Oak Sand- hill Scrub	Marine & Xeric Hammock	Coastal & Hy- dric Hammock	Cypress Dome	Pine Platewoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Passeriformes (continued)													
	<u>Seiurus motacilla</u>	Louisiana waterthrush								X			
	<u>Oporornis agilis</u>	Connecticut warbler				X				X			
	<u>Geothlypis trichas</u>	Common yellowthroat	*	X	X	X	X	X		X	X	X	
	<u>Icteria virens</u>	Yellow-breasted chat								X			
	<u>Wilsonia citrina</u>	Hooded warbler			X	X							
	<u>Melospiza melodia</u>	Song sparrow	*					X					

Table 2.7-10 Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page thirteen of sixteen)

Order	Family	Species	Common Name	Species Observed	Pinel/Oak Sand-	Hill Scrub	Mesic & Xeric Hammock	Coastal & Hydric Hammock	Cypress	Pinel	Placwoods	Pinel	Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Caudata	Sirenidae	<i>Siren lacertina</i>	Greater siren		X	X	X	X	X					X	X		
		<i>Siren intermedia</i>	Lesser siren		X	X	X	X	X					X	X		
		<i>Pseudobranchius striatus axanthus</i>	Narrow-striped dwarf siren		X	X	X	X	X					X	X		
		<i>Pseudobranchius striatus lustricolus</i>	Gulf hammock dwarf siren						X								
		<i>Ambystomatidae</i>															
	Ambystomidae	<i>Ambystoma cingulatum</i>	Flatwoods salamander						X								
		<i>Ambystoma talpoideum</i>	Mole salamander		X	X	X	X									
		<i>Ambystoma tigrinum tigrinum</i>	Tiger salamander		X	X	X	X									
		<i>Salamandridae</i>															
	Notophthalmidae	<i>Notophthalmus virideus</i>	Peninsula newt		X	X	X	X	X						X		
		<i>Plethodon</i>	Striped newt		X	X	X	X	X								
		<i>Desmognathus auriculatus</i>	Southern dusky salamander			X	X	X	X								
		<i>Pseudotriton montanus</i>	Hud salamander			X	X	X	X								
	Plethodontidae	<i>Plethodon glutinosus</i>	Slimy salamander			X	X	X	X								
		<i>Eurycea quadrigitata</i>	Dwarf salamander			X	X	X	X								
		<i>Amphiumidae</i>															
	Anura	<i>Amphiuma means means</i>	Two-toed congo eel						X					X			
		<i>Pelobatidae</i>															
	Leptodactylidae	<i>Scaphiopus holbrooki</i>	Eastern spadefoot toad		X	X	X	X									
		<i>Eleutherodactylus planirostris</i>	Greenhouse frog			X											
		<i>Ranidae</i>															
	Microhylidae	<i>Rana areolata</i>	Gopher frog		X	X	X	X	X								X
		<i>Rana catesbeiana</i>	Bullfrog		X	X	X	X	X						X		X
		<i>Rana clamitans</i>	Bronze frog			X	X	X	X								X
		<i>Rana sylvia</i>	Pig frog			X	X	X	X								X
		<i>Rana heckscheri</i>	River frog			X	X	X	X								X
		<i>Rana utricularia</i>	Southern leopard frog		X	X	X	X	X								X
	Microhylidae	<i>Microhyla</i>															
		<i>Gastrophryne carolinensis</i>	Eastern narrow-mouth toad		X	X	X	X	X								X

Table 2.7-10 Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page fourteen of sixteen)

Order	Family	Species	Common Name	Observed	Pine/Oak Sand-	Hill Scrub	Mesic & Xeric	Hammock	Coastal & Hy-	Cypress	Pine	Pine	Plantation	Mixed	Swamp	Fresh	Salt	Marsh	Developed	(Ruderal)
Bufo	querecius		Oak toad	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bufo	terrestris		Southern toad	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hyla																				
Acris	gryllus	dorsalis	Florida cricket frog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hyla	crucifer	bartramiana	Florida peeper	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hyla	cinerea	cinerea	Green treefrog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hyla	femorialis		Pine woods treefrog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hyla	gratiola		Barking treefrog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hyla	squirella		Squirrel treefrog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hyla	versicolor		Gray treefrog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pseudacris	nigrita	nigrita	Southern chorus frog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pseudacris	nigrita	verrucosa	Florida chorus frog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pseudacris	ornata		Ornate chorus frog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Limnodynastes	ocularis		Little grass frog	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Testudines																				
Chelydridae																				
Chelydra	serpentina	serpentina	Snapping turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Kinosternidae																				
Stenotherus	odoratus		Husk turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Stenotherus	minor		Loggerhead musk turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Kinosternon	bauri	bauri	Striped mud turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Kinosternon	subrubrum			*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
steindachneri				*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Emydidae																				
Terrapene	carolina	bauri	Florida box turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Malaclemys	terrapin		Diamondback terrapin	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chrysemys	floridana		Florida cooter	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chrysemys	concinna	savannahensis	Savannah cooter	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chrysemys	scripta		Yellow-bellied turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Deirochelys	reticularia		Chicken turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Testudinidae																				
Gopherus	polyphemus		Gopher tortoise	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cheloniidae																				
Chelonia	mydas	mydas	Atlantic green turtle	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eretmochelys	imbricata	imbricata	Atlantic hawksbill	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Caretta	caretta		Atlantic loggerhead	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lepidochelys	kempii		Atlantic ridley	*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 2.7-10 Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page fifteen of sixteen)

Order	Family	Species	Common Name	Species Observed	Pine/Oak Sandhill Scrub	Marine & Xeric Hammock	Coastal & Hydro Hammock	Cypress Dome	Pine Flatwoods	Pine Plantation	Mixed Swamp	Fresh Marsh	Salt Marsh	Pasture & Developed (Ruderal)
Dermochelyidae	Dermochelys	<u>coriacea</u>	Atlantic leatherback										X	
		<u>trionychidae</u>	Florida soft-shelled turtle									X		
		<u>ferox ferox</u>												
Crocodylia	Alligatoridae	<u>alligator mississippiensis</u>	American alligator	*					X		X	X	X	
		<u>iguana</u>												
Squamata	Iguanidae	<u>anolis carolinensis</u>	Green anole	*	X	X	X	X	X	X				
		<u>sceloporus undulatus</u>	Fence lizard	*	X	X	X	X	X	X				
		<u>sceloporus woodi</u>	Florida scrub lizard		X	X								
Scincidae	Leiolopisma	<u>laterale</u>	Ground skink	*	X	X	X	X	X	X	X			X
		<u>fasciatus</u>	Five-lined skink		X	X	X	X	X	X				
		<u>laticeps</u>	Broad-headed skink	*	X	X	X	X	X	X				
Eumeces	Eumeces	<u>inexpectatus</u>	Southeastern five-lined skink		X	X	X	X	X	X				
		<u>egregius onocrepis</u>	Peninsula mole skink		X	X	X							
		<u>sexlineatus</u>	Six-lined racerunner	*	X	X				X				X
Anguillidae	Ophisaurus	<u>ventralis</u>	Eastern glass lizard	*	X	X	X	X	X	X		X		X
		<u>longicauda</u>	Slender glass lizard		X									
		<u>compressus</u>	Island glass lizard		X	X			X					
Colubridae	Rhinoceros	<u>floridana</u>	Worm lizard		X	X	X							
		<u>pictiventris</u>	Banded water snake	*	X	X	X	X	X	X	X	X	X	X
		<u>fasciata clarki</u>	Gulf salt marsh snake									X	X	
Natrix	Natrix	<u>cyclopion</u>	Green water snake					X	X			X	X	
		<u>rigida</u>	Glossy water snake											
		<u>taxiplota</u>	Brown water snake								X			
Liodytes	Liodytes	<u>alleni</u>	Striped swamp snake					X	X			X	X	
		<u>pygmaea</u>	Black swamp snake		X	X	X	X	X	X		X		X
		<u>sauritus sackeni</u>	Peninsula ribbon snake		X	X	X	X	X	X		X		
Thamnophis	Thamnophis	<u>sauritus nitae</u>	Blue-striped ribbon snake			X	X	X						
		<u>sirtalis similis</u>	Blue-striped garter snake	*										
		<u>virginia stritula</u>	Rough earth snake					X	X	X				
Storeria	Storeria	<u>occipitomaculata</u>	Red-bellied snake	*		X	X	X	X	X		X	X	X
		<u>dekayi</u>	Brown snake											

Table 2.7-10 Relative Abundance and Preferred Habitat of Vertebrates Known or Expected to Occur in the Vicinity of the Proposed Plant Site, Citrus County (Continued, page sixteen of sixteen)

Order	Family	Species	Common Name	Species Observed	Pine/Oak Scrub	Marine & Xeric	Coastal & Hy-	Cypress	Pine	Pine	Mixed	Swamp	Fresh	Salt	Pasture &	(Budding)
Anguillidae (continued)																
Anguillidae	Heterodontidae	<i>Heterodon platyrhinos</i>	Eastern hognoose snake		X	X	X								X	X
		<i>Heterodon albus</i>	Southern hognoose snake		X	X	X								X	X
		<i>Diadophis punctatus</i>	Ringneck snake	*		X	X		X	X	X					
		<i>Rhadinea flavilata</i>	Pinewoods snake			X	X		X	X	X					
		<i>Farancia erythrogramma</i>	Rainbow snake			X	X		X	X	X					
		<i>Farancia abacura</i>	Mud snake			X	X		X	X	X					
		<i>Coluber constrictor</i>	Black racer	*	X	X	X		X	X	X					
		<i>Nasticophis flagellum</i>	Eastern coachwhip	*	X	X	X		X	X	X					
		<i>Ophedrys aestivus</i>	Rough green snake		X	X	X		X	X	X					
		<i>Elaphe guttata guttata</i>	Corn snake		X	X	X		X	X	X					
		<i>Elaphe obsoleta williamsi</i>	Gulf hammock rat snake	*	X	X	X		X	X	X					
		<i>Pituophis melanoleucus mugitus</i>	Florida pine snake		X	X	X		X	X	X					
		<i>Drymarchon corais couperi</i>	Indigo snake	*	X	X	X		X	X	X					
		<i>Lampropeltis getulus getulus</i>	Eastern kingsnake			X	X		X	X	X					
		<i>Lampropeltis triangulum</i>	Scarlet kingsnake		X	X	X		X	X	X					
		<i>Elapsoidea</i>	Scarlet snake		X	X	X		X	X	X					
		<i>Cemophora coccinea</i>	Short-tailed snake		X	X	X		X	X	X					
		<i>Stolonoma extenuatum</i>	Florida crowned snake		X	X	X		X	X	X					
		<i>Tantilla relicta neilli</i>	Eastern coral snake		X	X	X		X	X	X					
		<i>Elapidae</i>														
		<i>Micrurus fulvius fulvius</i>	Florida cottonmouth		X	X	X		X	X	X					
Viperidae	Agkistrodon	<i>Agkistrodon piscivorus conanti</i>	Dusky pigmy rattlesnake	*		X	X		X	X	X					
		<i>Sistrurus miliarius barbouri</i>	Canebrake rattlesnake			X	X		X	X	X					
		<i>Crotalus horridus striscudatus</i>	Eastern diamondback rattlesnake	*	X	X	X		X	X	X					
		<i>Crotalus adamanteus</i>														

Table 2.7-11 Qualitative Small Mammal Trapping From Habitats at the
Proposed Site: August 1977

Community/Number of Trap Nights	Cotton Rat	Cotton Mouse	Florida Mouse	Short-Tail Shrew
Pine Flatwoods (68 Trap Nights)	7	6	--	1
Hydric Hammock (94 Trap Nights)	--	29	--	1
Coastal Hydric Hammock (94 Trap Nights)	--	31	--	1
Evergreen Oak Scrub (18 Trap Nights)	--	1	2	--

Source: Environmental Science and Engineering, Inc., 1977.

Interfaces between different plant communities are also important to wildlife. These areas, known as edges, support a denser, more diverse fauna (Odum, 1971). The large continuous coastal hammock forest of western Florida and the adjoining salt marsh support a variety of game and non-game species. On forested lands, forest edge and successional thickets may harbor greater concentrations of deer, songbirds, quail, and rabbits. In general, the interspersed plant communities and increased edge has provided a suitable habitat for a very diversified fauna.

On the project area, the abundance of browse and mast-producing species, combined with the extensive variety of ecotones and plant communities, provides a substantial amount of food and potential denning and nesting sites for many species. Acorns are a major source of food for many species of wildlife for much of the year (Goodrum, et al., 1971). Acorn production, although not evenly distributed in the plant communities, is considerable because of the large number of well-formed oak trees. Wildlife species on the site known to utilize acorns as a staple food source include deer, turkey, gray and fox squirrel, quail, blue jay, and a host of other species. Browse species, i.e., greenbrier, sumac, grasses, and legumes, as well as non-acorn, mast-producing species (dogwood, persimmon, grape, maple, poison ivy, and wax-myrtle) can be important to wildlife. Production of fruit by small trees, shrubs, and vines may exceed acorn production.

Salt Marsh

Vertebrate wildlife diversity in salt marshes is relatively low compared to other habitats due to the changing conditions placed upon inhabitants by fluctuating water levels, varying salinity, and exposure. The marsh, however, does provide important support such as breeding and resting grounds for some species, particularly for waterfowl. Animal activity is directly related to tidal fluctuations (Johnson, et al., 1974). Most of these species have mechanisms enabling them to escape tidal flooding. In the salt marsh, the detritus food chain predominates. Animals

occurring in the salt marsh may be exclusives (marsh wrens, clapper rails, willet, seaside sparrow, and diamondback terrapin) as well as ubiquitous forms (raccoons, river otter, mink and crows) which utilize a large variety of habitats. Many species are occasional inhabitants utilizing the marsh either seasonally or on a short-term (daily) basis.

Few species of herptiles occur regularly in the salt marsh. Characteristic reptiles of the salt marsh include the ornate diamondback terrapin, blue-striped garter snake, blue-striped ribbon snake, and Gulf salt marsh snake. Occasional inhabitants are the American alligator, Suwannee cooter, eastern indigo snake, and a few species of frogs. Some breeding birds which commonly occur are long-billed marsh wren, seaside sparrow, clapper rail, and common yellowthroat. These areas are also utilized extensively as feeding grounds by such birds as hawks, gulls, white ibis, blackbirds, grackles, herons, belted kingfishers, terns, and black skimmers. Characteristic marsh mammals are marsh rabbit, rice rat, and raccoon. Hispid cotton rat, cotton mouse, river otter, and mink are resident species of the salt marsh as well as other habitats.

Fresh Marsh

Although fresh marshes occupy a very small acreage in the proposed power plant site, these areas are nevertheless very important to some species of wildlife, particularly as feeding and watering sites. These wetlands are used extensively by wildlife whenever succulent emerging vegetation is present. White-tailed deer, marsh rabbit, and a variety of small mammals regularly feed in such areas. Various herons and egrets frequently prey upon small vertebrate and invertebrate populations found in these wetlands. Many of the species typical of freshwater marshes were not observed, probably because of the small size and ephemeral nature of these systems on the project area.

6/2/80

Pine Flatwoods

Most wildlife of the on-site pine flatwoods use the ground stratum for feeding, nesting, and cover. Generally, pine flatwoods do not support sizable populations of game species except where disturbance has occurred and where there is an interspersed of other vegetative types (Ripley, et al., 1962).

Portions of the pine flatwoods have an incomplete canopy cover, and as a result, numerous species of shrubs and herbaceous plants are found in scattered areas. These ground species may include saw-palmetto, wire grass, gallberry, blueberry, huckleberry, numerous grasses, sedges, and forbs. These plants produce a large amount of fruit and leafy material on which herbivorous and omnivorous animals feed extensively. In some sections of the pine flatwoods, the dense palmetto retards the growth of many important food plants. Palmetto foliage provides cover and nesting sites, but it is relatively low in food value to wildlife. In other sections, the ground stratum is relatively free of palmetto and gallberry and contains various legumes, grasses, and other low herbaceous plants. These plants are important food sources for such species as quail, dove, cotton rat, cottontail rabbit, deer, and many passerine birds. Acorn production is very limited in the pine flatwoods.

The most commonly encountered herptiles were the six-lined racerunner, oak toad, black racer, Florida box turtle, and gopher tortoise. Bird species observed were rufous-sided towhee, carolina wren, bobwhite quail, ground dove, mourning dove, blue-gray gnatcatcher, and red-bellied woodpecker. The hispid cotton rat is characteristic and was collected during the study. Other mammals frequently encountered were the nine-banded armadillo, cotton mouse, raccoon, eastern cottontail rabbit, short-tail shrew, eastern mole, and gray squirrel.

Pine Plantation

Faunal associations of the pine plantation are similar to those found in the pine flatwoods. In terms of wildlife production, pine plantations are most productive during the first 5 to 7 years, before canopy closure occurs and while herbaceous vegetation is still abundant. As canopy closure occurs, ground vegetation is shaded out and the abundance and diversity of wildlife decreases (Smith, 1958; Bailey and Alexander, 1960). Wildlife frequenting such homogeneous forest stands as pine plantation are generally found around the edges and openings where habitat diversity is greatest (Umber and Harris, 1974; Pearson, 1968). Species of wildlife observed were generally the same as those occurring in the pine flatwoods.

Evergreen Oak Scrub

Conditions of the evergreen oak scrub community are extremely dry and hot because of the absence of overstory and the less dense understory vegetation. Typically, this community occurs on higher well-drained fine sands. Food-producing plants are rather sparse in the understory and herbaceous plants essentially are absent in the ground stratum although some acorn production does occur in these areas. Species of wildlife within this association have made several adaptations to the dry, hot conditions by being active only at night, utilizing subterranean retreats, or being armored. The gopher tortoise is an example of these adaptations. The den of the gopher tortoise is often used as a retreat or hibernaculum by such species as black pine snake, indigo snake, gopher frog, Florida mouse, and diamondback rattlesnake.

The herptile fauna of these areas was sparse, with the gopher tortoise, six-lined racerunner, black racer and oak toad the only species encountered. Other reptiles and amphibians known to occur in this habitat are sand skink, crowned snake, worn lizard, brown mole skink, short-tailed lizard, scrub lizard, and slender glass lizard. The scrub jay, the only

characteristic bird of this habitat, was not encountered on-site. Other common species observed included the brown thrasher, mockingbird, white-eyed vireo, and carolina wren. Two Florida mice were trapped in these areas. No other mammals were observed in this community although they probably occur.

Mesic Hammock

The mesic hammock association occurs on relatively high land in moderately moist soils. Canopy cover reaches almost a maximum; subsequently herbaceous vegetation is usually sparse with blueberry prevalent in scattered localities. The wildlife of the mesic hammock shares some components with that of the hydric hammock. The relatively moist environment in the mesic hammock allows the presence of creatures which must have considerable moisture available for their survival.

Herptiles found in this habitat were the slimy salamander, eastern garter snake, Gulf Hammock rat snake, eastern indigo snake, the Florida red-bellied snake, the eastern diamondback rattlesnake, and the broad-headed skink. The barred owl and turkey are characteristic year-round resident birds. An assortment of birds was observed in this habitat (Table 2.7-10). Frequently encountered mammals were the gray squirrel, cotton mouse, raccoon, and nine-banded armadillo.

Hydric Hammock and Coastal Hydric Hammock

Because of the vegetative diversity and alteration of dry and wet habitats, these forested communities offer a greater diversity of microhabitats than most other ecosystems in the study area. These habitats often may serve as wildlife reservoirs (when surrounding lands are stressed by draughts, fire, or human disturbance). The fauna of these habitats is generally a mix of species of aquatic habitats as well as the more upland habitats. Mast production is considerable, and herbaceous growth is abundant in most sections.

Few exclusive species of herptiles occur in hydric hammocks. The most commonly encountered species were green tree frog, green anole, and narrow-mouthed toad. Other species observed were Gulf Hammock rat snake, broad-headed skink, and slimy salamander.

Bird occupancy of hydric hammock varies seasonally. Breeding summer residents include swallow-tailed kite, red-eyed vireo, acadian flycatcher, and prothonotary warbler. Among the assortment of other birds which use these habitats are eastern kingbird, great crested flycatcher, carolina wren, yellow-billed cuckoo, northern parula warbler, pileated woodpecker, and red-bellied woodpecker. Mammals commonly noted in these areas were deer, raccoon, river otter, and cotton mouse. In addition, these habitats and mixed swamp may be the last retreat for the Florida panther and black bear in some sections of the southeast (Wharton, et al., 1976).

Ruderal Areas

These are areas where most or all native vegetation has been removed or altered by human activity. This habitat is characterized by plant communities which are in some form of the early successional process. Food plants mainly consist of various grasses and sedges. Bare substrate is often present with rubble and exposed limestone rock occurring. Cover and denning sites are very sparse. The fauna of such areas was rather depauperate. Birds found in this habitat included the mocking bird, loggerhead shrike, meadowlark, and killdeer. No mammals were observed in these areas. The eastern diamondback rattlesnake and the gopher tortoise were the only sensitive species encountered.

Wellfield Site

The well field to be used during operation of Units 4 and 5 will be within the existing powerline corridor east of Highway 19 and will extend over an east-west linear area of about 3,150 meters (10,300 feet). It is estimated that the potential area of impact would

6/2/80

include an area of no more than 1.6 kilometers (1 mile) of the field in any direction (Section 5.3).

Plant communities in this well field area are slash pine flatwoods, freshwater marsh, mesic hammock, and ruderal areas (improved pasture and the transmission corridor). Toward the east, the hammocks and flatwoods acquire a more xeric nature, and grade into xeric hammock and sandhill vegetation. Slash pine flatwoods and pasture account for over 75 percent of the cover. The marshes in this area are generally larger, deeper, and more permanently flooded than are those at the site. Consequently, they appear to have greater species diversity and higher productivity. The communities of this area are more characteristic of the region than are those on the plant site because of the greater depths of the soil layers overlying the rock substrate. Consequently, the pasture and flatwoods soils are characteristic pine flatwoods soils.

Animal habitat in this area is less diverse than on-site, with fewer ecotones (edges). Animal species expected are those shown in Table 2.7-10 for the above communities. The area provides better habitat for species of open communities and poorer habitat for species of heavily wooded communities than the plant site. Because of their larger size, greater depth, and prolonged inundation, these marshes are better quality habitat for wading birds and waterfowl than the marshes on-site. The western end of the wellfield area near Highway 19 is beginning to undergo commercial and residential development.

FUNCTION/DYNAMICS

Plant/Soil/Water Relationships

The plant communities of Florida have consistently been found to be closely related to the prevalent soil types and the depth and duration of flooding (Pessin, 1933; Lassle, 1958; Monk, 1966, 1968; Wharton, et al., 1976). This pattern also exists on the proposed site, but the proximity of the limestone substrate to the surface tends to compress a

wide variety of soil and moisture conditions into a small geographic area. These conditions provide for a high diversity of plant communities.

Pine flatwoods in Florida generally occur in low-level, sandy areas with acidic soils and a relatively high water table, while mesophytic hardwoods (mesic hammock) normally occur on well-drained sands overlain by organic matter with water table depths in excess of 100 centimeters (40 inches). Hydric hammocks and marshes are often found on peats and mucks from 0.6 to 3.0 meters (2 to 10 feet) deep. Scrub areas may have well-drained sands over 30 meters (100 feet) in depth (Snedaker and Lugo, 1969).

Figure 2.7-3 illustrates that vegetational community types and zonation patterns similar to those described above have developed on-site even in the absence of the usual major variations in soil depth and elevation. In this coastal region, very small changes in elevation, soil type, and soil depth result in relatively major changes in vegetation and flora, as seen in the following examples.

Hydric hammock is distinguished from mesic hammock as areas where the top 0.3 to 0.6 meters (1 to 2 feet) of substrate has dissolved or subsided and has left a sink-like depression. Sands and mucks in these hammocks are very thin and range from less than 20 centimeters (8 inches) to about 0.6 meters (2 feet) where mesic hammock grades into flatwoods. This area appears to be internally drained largely through dissolution cavities, since few surface drainage patterns exist. Consequently, the water balance of these hammocks is probably closely associated with the groundwater flow through the Floridan Aquifer, which may retard the drying of hydric hammocks in the dry season. Water levels in hydric hammocks, judging by water marks on tree trunks, are in the range of 0.3 to 0.6 meters (1 to 2 feet) during the wet season.

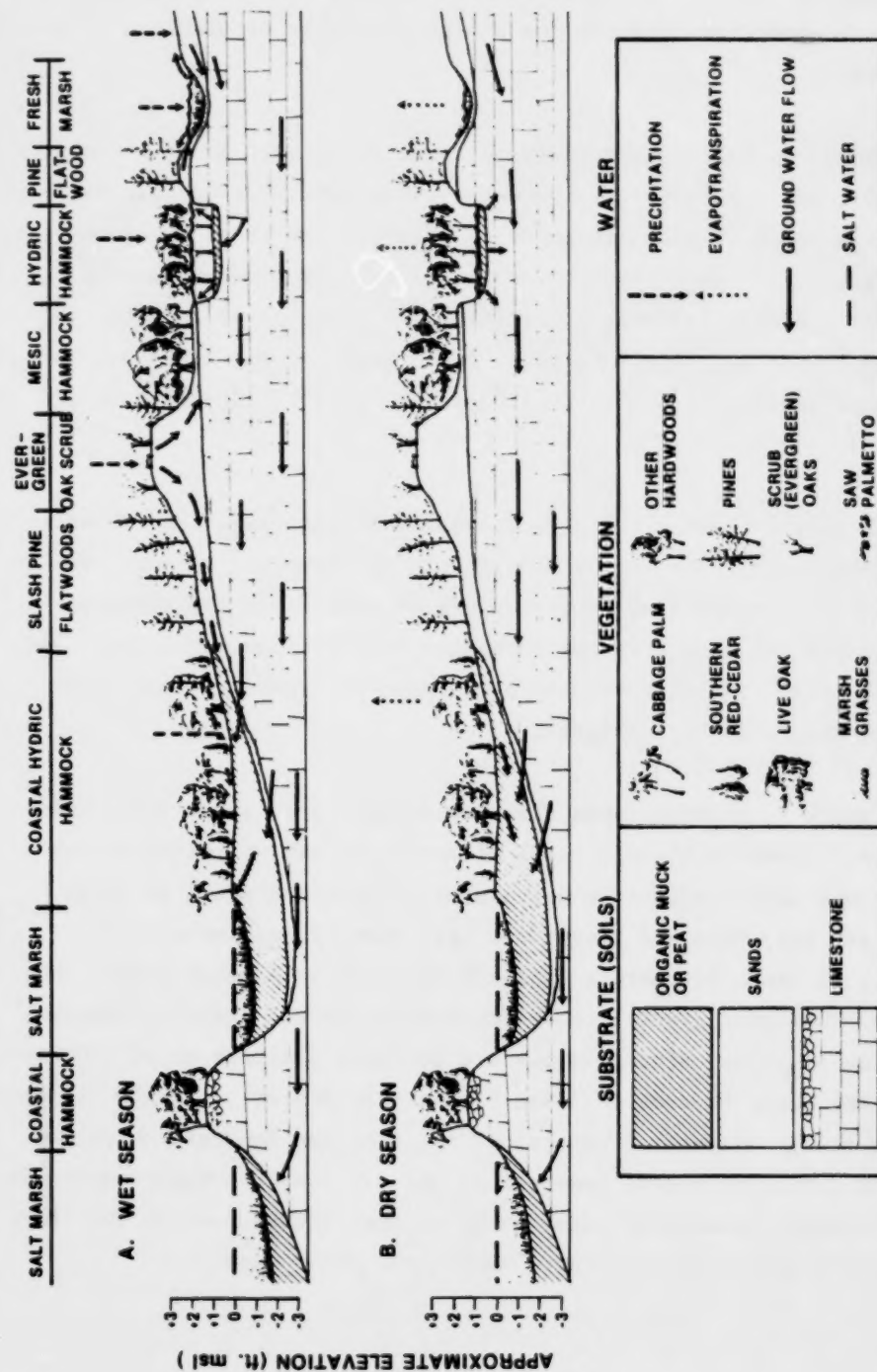


Figure 2.7-3
CONCEPTUALIZED PLANT/SOIL/WATER RELATIONSHIPS OF THE
PROPOSED PLANT SITE

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

Pine flatwoods occur where the sands are slightly deeper [0.3 to 1 meter (1 to 3 feet)] and where the underlying rock seems less consolidated. Drainage from this area is probably largely subsurface along the top of the confining layer. The areas of evergreen oak scrub occur where the sands are greater than three feet in depth.

Freshwater marshes on the site are generally small depressions in the pine flatwoods. Only rarely is there a buildup of organic material [the deepest observed was 15 centimeters (6 inches)]. Most of the marshes have a layer of clay or marl less than 5 centimeters (2 inches) in thickness over the hard calcareous substrate. Although the smaller marshes have the appearance of borrow pits, the soil profile is similar to that of the larger marshes. These marshes are probably maintained by surface and subsurface drainage of the surrounding areas and lose more water through evapotranspiration than by percolation into deeper layers.

The ruderal areas in the transmission corridor were found to have soil depths of 8 to 38 centimeters (3 to 15 inches) before an impenetrable layer was reached. No differences between the ruderal swamp, marsh, and upland areas were readily apparent.

The coastal hydric hammock differs from the rest of the site area by having definable surface drainage and a relatively deep organic layer up to 1 meter (3 feet). In some areas a sand layer up to 0.6 meters (2 feet) thick lies between the organic layer and the limestone. Coastal hydric hammock soils generally are poorly drained with the water table maintained by the more or less constant discharge of springs (Wharton, et al., 1976). Rainfall usually results in some surface flooding.

Coastal hydric hammock is subject to periodic salt-water flooding during storm events (Wharton, et al., 1976). As a result, chlorides may accumulate in the soil during dry periods and may restrict the occurrence of certain salt-tolerant species.

In the salt marsh, the sand/organic soils are of the saltwater marsh association (Florida Division of State Planning, 1974), and are generally flooded by tidal waters. Distribution of species is generally governed by depth of flooding and salinity content (Kurz and Wagner, 1957; Adams, 1963).

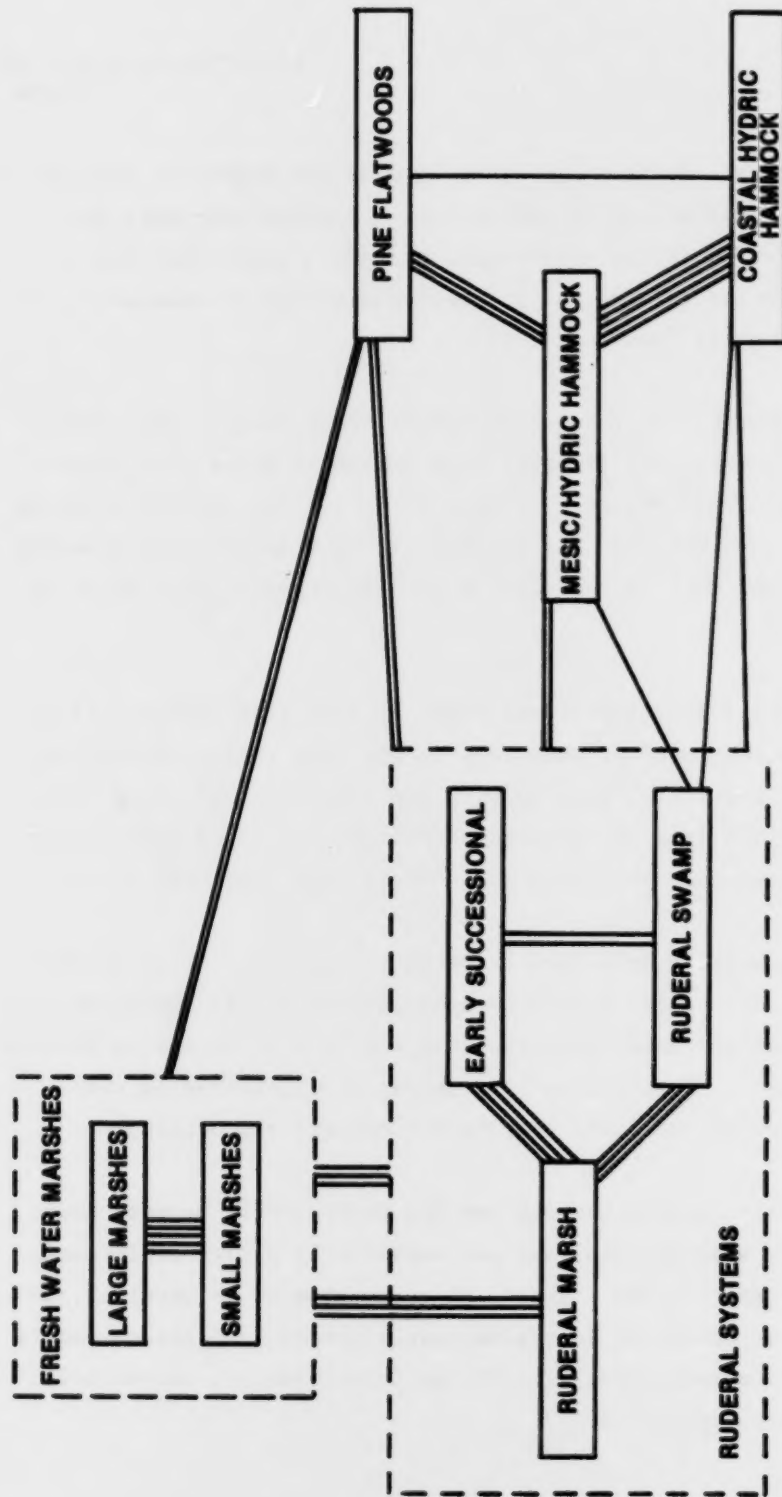
Successional and Community Relationships

Figure 2.7-4 represents the degree of relationship of the on-site communities which were sampled, based upon Sorenson's Index for the similarity of species composition (see Chapter 6). Although this analysis does not yield a statistically valid comparison of the vegetative communities on-site, it does give a general picture of the community relationships. The figure shows that the fresh marshes in the natural areas are essentially similar, regardless of size, whereas the marshes in the ruderal areas are more similar floristically to the upland early successional or old field areas.

The limited similarity between the shrub swamps in the transmission corridor and the mature wetland forest swamps implies that the three subtypes of the ruderal area are not closely related to the more natural areas on the site and thus represent an altered and somewhat artificial system.

The three forest types appear to represent a continuum, with pine flatwoods and coastal hydric hammock similar to mesic/hydric hammock, but not to each other.

Each of these types has been described as a discrete community occurring in a particular environmental condition. However, because of the complex interaction of many factors, including time, there can be



NUMBER OF LINES CONNECTING TWO SPECIES TYPES IS PROPORTIONAL TO DEGREE OF SIMILARITY
BROKEN LINES CONTAIN BROAD ASSEMBLAGES OF TYPES EXPLAINED IN THE TEXT

Figure 2.7-4
SIMILARITY OF ON-SITE PLANT COMMUNITIES BASED ON SPECIES COMPOSITION

SOURCE: FROM MONK, 1968
ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

considerable overlap of these types, as seen by the degree of species similarity over a sufficient period of time. A plant community may undergo an alteration in its environment to such a point that the process of succession occurs, which involves a change in community structure and function (Oosting, 1956).

A generalized schematic of this successional trend (Monk, 1965, 1968; Quarterman and Keever, 1962; Florida Game and Fresh Water Fish Commission, 1976; Veno, 1976; Wharton, et al., 1976) for the site is shown in Figure 2.7-5. Human activity has resulted in substantial past clearing of the area so that most of the site is in a relatively early stage of development.

Calculation of the age of individual trees by tree ring analysis (Figure 2.7-6) shows that most of the trees in the pine flatwoods area are between 4 and 15 years old, with an even age distribution. This distribution, along with a lack of hardwood seedlings, indicates that recent disturbance has returned this area to an early pine flatwoods stage.

The trees in the mesic/hydric hammock being younger than trees of the same species in the coastal hydric hammock (Figure 2.7-6) indicates that this area has been disturbed more recently and that it is not an old-age mature climax stand. However, both areas can be considered in the climax stage since the dominant overstory trees are reproducing.

Although the coastal hydric hammock and the mesic/hydric hammock areas are floristically similar, they are not necessarily a part of the same successional series. In the figures, they are treated as parallel successional patterns occurring in predominantly coastal and predominantly inland environments respectively, although intergradation undoubtedly can occur (Wharton, et al., 1976).

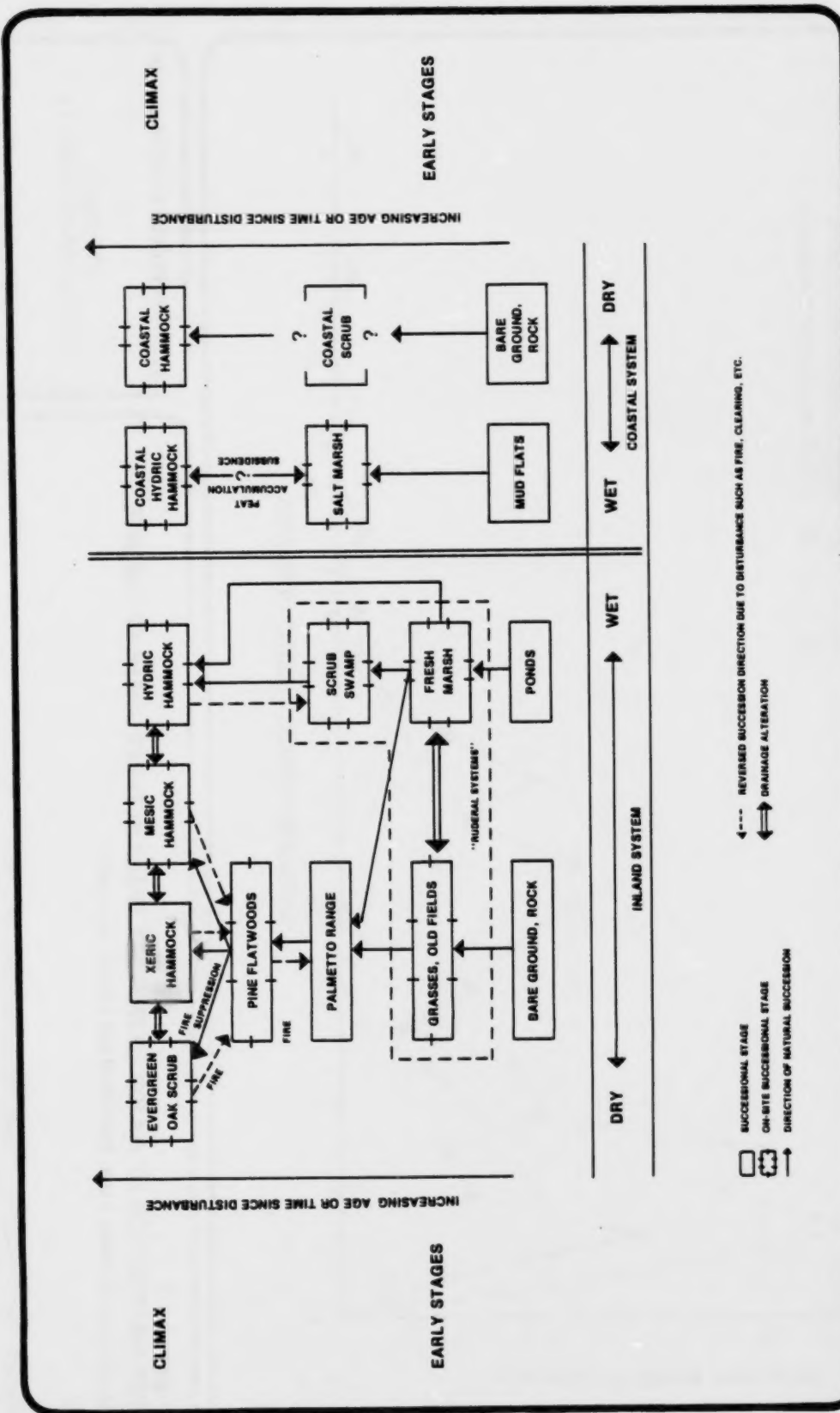


Figure 2.7-5
GENERALIZED TREND OF PLANT SUCCESSION ON PROPOSED SITE

SOURCE: AFTER MONK, 1968
 ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

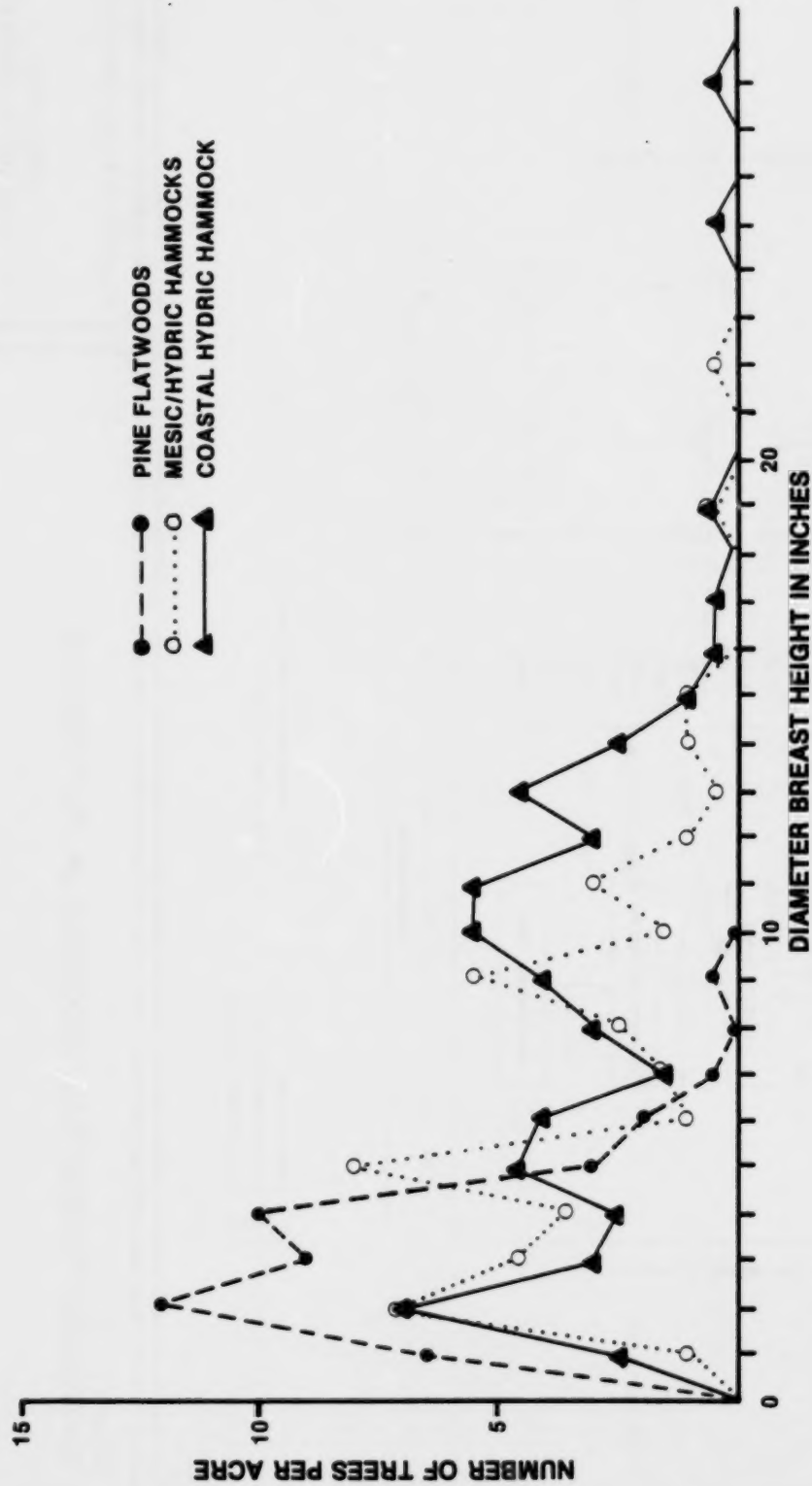


Figure 2.7-6
SIZE DISTRIBUTION OF MAJOR OVERSTORY TREES IN THREE AREAS OF THE SITE
 (SLASH PINE, CABBAGE PALM, SOUTHERN RED CEDAR, ALL OAKS)

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Animal succession proceeds with the same general pattern as plant succession--increase in diversity and specialization of organisms with time (Beckwith, 1954; Hirth, 1959; Johnston and Odum, 1959). However, patterns of change are not as dramatic as from one plant seral stage to the next stage. The presence or absence of animals is a function of vegetative types and the amount of cover. In many cases, the plant composition will change, but the effective cover or general tree life form will remain the same and resulting animal populations will generally be the same. The greatest differences in animal succession occur from grassland/pasture to shrub and from shrub to forest.

Given natural succession at the plant site, the animal communities will change little in the salt marsh and mesic/hydric hammock as compared to the longleaf/slash pine flatwood communities over the next 15 years. As mentioned in the previous section, the marshes are in a relatively stable state and little change is expected in the vegetation and in animal communities. Since the mesic/hydric hammocks are not old-age mature climax stands, the understory and ground cover are more extensive than would be expected in a more mature stand. However, the changes which occur in the lower strata have a more long-term effect and will not drastically alter the present animal fauna.

The pine flatwood communities have recently been logged, and the area is in a disclimax shrub and early forest growth state. With the further development of pines (providing fire does not occur in the area) and a subsequent reduction of shrub and understory areas, the species normally associated with these areas will change. Based on general patterns seen in eastern North American forests, the density of birds and mammals should decline in this mid-successional period (Hirth, 1959; Johnston and Odum, 1956; Pearson, 1959). The condition of the pine flatwoods is now conducive to granivorous, insectivorous, and fructivorous birds. As succession proceeds, the insectivorous and fructivorous species, as well as the omnivorous birds, will increase. The changes in mammal

populations will be more quantitative than qualitative since most of the later seral stages of mammals are present.

Species Interaction

Many organisms of a given community often have dependent associations and similar niche requirements. The relationships of organisms with these dependencies and overlapping habitat requirements result in a particular animal community. It is this assemblage that gives an ecosystem its characteristic structure and function. The intricate interactions involved in a particular assemblage of organisms can be described best by a schematic of food chains and particular species associations.

Figure 2.7-7 is a generalized representation of the types of interactions that occur or can be expected to occur at the proposed site. Because the feeding behavior of some species involves them in more than one trophic level, a food web rather than a food chain is depicted.

Food chains commonly contain three to five trophic levels: a plant (primary producer), an herbivore (primary consumer), and one or more carnivores (secondary consumers). The several interacting food chains represented in this diagram describe the food web of the site. The panicum grass/cotton mouse/diamondback rattlesnake relationship is typical of the grazing (herbivore) food chain (Figure 2.7-7).

Panicum grass is a primary producer, using solar energy for the manufacture of food. An herbivore, the cotton mouse, assimilates the food produced by green plants and thus fulfills the role of a primary consumer. Primary consumers are in turn fed upon by such animals as the diamondback rattlesnake, the secondary consumers. The decomposers operate at all levels and serve as a pathway for the recycling of mineral nutrients back to lower trophic levels. These types of

interactions are often more complex and may involve the same animals at different trophic levels. For example, quail may feed on grasses and also on insects and thus are primary consumers and secondary consumers, respectively (Figure 2.7-7).

Some organisms, such as man, fox, bobcat, and red-tailed hawk, are more mobile and thus may remove some food (energy) from one ecosystem to another. Other symbiotic relations involve organisms in such association as competition, amensalism, parasitism, mutualism, commensalism, and neutralism. A typical interaction occurs between squirrels, jays, and quail (Figure 2.7-7). They all feed on acorns and thus are seemingly in direct competition. Squirrels and jays may be in direct competition for acorns still on the tree; however, quail cannot eat the fruit until the shell has been cracked and dropped to the ground by these arboreal species. Thus the quail are dependent upon the activity of other animals. Another example of species interactions is the use of the gopher tortoise burrow as a retreat by such species as the Florida mouse and the indigo snake. These animals may not be able to survive in certain habitats without the presence of the gopher tortoise. These symbiotic relationships are extensive and apparently involve most organisms of the forested ecosystems.

Influencing Factors and Stresses

As noted previously, the primary natural factors influencing the development and function of the natural systems are soil and moisture factors, and proximity to the coast; however, a large portion of the proposed site has been periodically altered by man's activities.

Wells (1942), Boyce (1954), Martin (1959), and Lassle and Monk (1961), showed that vegetational zonation in coastal forest communities is correlated to salt spray intensity. The coastal hydric hammock community on-site appears to have these same zonal characteristics with decreasing canopy height and cover plus an elimination of non-tolerant

species near the coast. These studies are based on Atlantic coast systems of beach, dune, and surf zones. Variation in wind pattern, lower elevation, and the presence of a wide marsh band at the Gulf Coast site may decrease salt spray intensity and thus increase the relative importance of other factors such as saltwater flooding, soil salinity, and hydroperiod. The coastal portions of the system at the site appear to have numerous fallen branches and trees, particularly cabbage palms. Whether this is a natural occurrence or a sign of increased stress is not known. Possible influences could be a submerging coastline and alterations in surface or ground water drainage patterns.

Stumps in the coastal hydric hammock indicate that selective logging has occurred in the past. Other parts of the coastal hydric hammock system have been logged extensively for cedar (Wharton, et al., 1976).

Upland areas have also been influenced by clearing and fire. Fire is a common natural event in the Florida pine flatwoods (Edminston, 1965; Snedaker and Lugo, 1972). Aerial photographs of the site taken in 1967 show that the upland areas had been cleared recently. Areas east and north of the site have since been planted as pine plantations, while the on-site area has undergone natural secondary succession to its current state. No fire or clearing has occurred since.

Fire and clearing affects wildlife in the area through immediate, short-term stress, depending on the season and the intensity of the fire (Dames and Moore, 1974). Clearing produces similar effects, but also may lead to long-term habitat and population loss of less mobile species, such as the gopher tortoise and its associates. Early successional communities (like those created on-site) provide habitat for rabbits, quail, rodents, snakes, and other wildlife which would otherwise decline with continued succession and absence of fire (Snedaker and Lugo, 1972).

Animal populations also are influenced by the density of the vegetation. The dense pine and palmetto areas on the site would favor small, ground-dwelling species such as rodents and snakes, while the open pine plantations would favor larger mammals and the soaring raptors (i.e. red-tail hawk).

Fire ants (Solenopsis sp.) have also been reported as a possible stress factor on animal populations near the proposed site. The ants occurred primarily along windrows and field edges in pine plantations and old fields (Dames and Moore, 1974). Ground dwelling or nesting wildlife are susceptible to fire ant predation, with consequent lowered nesting success and population declines. Fire ants were not observed to be a problem during 1977 field surveys, which may have been due to sampling in different locations, prior fire ant eradication programs, or habitat changes due to natural succession.

Air pollution does not appear to be a problem in the general area, although one assemblage of plants was noted in which leaf injury patterns similar to those of air pollution injury were seen. These few plants, in an area of about 100 square meters (1,000 square feet) near the northeast corner of the existing ash pond, had the following appearance:

- Grape--mild chlorosis (yellowing) of the leaves with brown spotting;
- Vetch--necrotic (brown) tip burn of leaves;
- Wild lettuce--mild chlorosis with white spotting of intervein portions of leaves;
- Greenbrier--red leaves with brown and green spotting;
- Saw palmetto--yellow leaves with brown, black, and white spotting;
- Blackberry--chlorosis of leaf margins and intervein areas.

These symptoms are common in a wide variety of natural circumstances, and are certainly not specific to atmospheric causes. Their occurrence in a wide variety of species in a narrow geographic area, however, is

indicative of some type of stress. Sulfur dioxide leaf damage is often evidenced by chlorotic streaking with stippled reddish-brown spots, and pale, collapsed or necrotic spots; ozone damage is evidenced by collapsed necrotic areas and red-brown spots; PAN injury is evidenced by glazed appearance and collapsed underside; fluoride damage is evidenced by necrotic tip burn and chlorotic banding (Brandt and Heck, 1968; National Environmental Research Center, 1973; Jacobson and Hill, 1970). Other factors known to cause similar symptoms include: bacterial, viral, and fungal diseases; insect infestation (National Environmental Research Center, 1973); temperature, wind burn (Brandt and Heck, 1968); salt spray (Boyce, 1954); and nutritional status and senescence. Since the concentrated symptoms appear only in a small area, it is likely that the cause is an isolated event and not atmospheric in nature, although air pollution cannot be ruled out.

VALUE AND SERVICE

Wildlife Production

Overall, the area can be considered excellent wildlife habitat. The proposed site supports small game species, such as gray squirrel and bob-white quail, and large game, such as white-tailed deer. Other game species present are rabbit, mourning dove, and feral swine, although populations of any one species are not large. The hydric hammocks in the area are good year-round habitat for wood duck as they furnish nesting trees and ample food. Apparently, there are very few wild turkey in the area because of the lack of suitable acreage of prime habitat. Non-game species which occur in the area include flying squirrel, alligator, fox, raccoon, river otter, bald eagle, osprey, and a multitude of wading birds and passerine birds. The herpetofauna is rich and reflects the diversity of habitat.

Forest Products

Approximately 61 percent of the land area of Citrus County is commercial forest, holding volumes of 330 million board feet of sawtimber and 2.8 million cubic meters (99 million cubic feet) of growing stock (Snyder and Knight, 1970). About 20 percent of this land is in pine, with various oak associations comprising the remaining stands. Although 14 percent of the area within an 8-kilometer (5-mile) radius of the proposed site has recently been planted in slash pine plantations, this area does not appear to be prime timber land. Site quality index is a term relating the height which a stand will attain at a certain age, usually rotation (harvest) age (Westveld and Peck, 1951). Barnes (1955) has established that Florida slash pine plantations of 10 to 15 years of age and tree heights of 3 to 5 meters (10 to 15 feet) (such as those near the site) have low (poor) site quality index values of 30 or 40, as opposed to values of 80 in high quality stands. Barnes and Ralston (1952) found that the best height growth in slash pine plantations occurred when the depth to the fine textured sands and clays was between 80 and 100 centimeters (30 and 40 inches), with a sharp decrease in growth of lesser depths. These results imply that the thin surface sands of the site may not be suitable for good pine production, although more inland areas may be suitable.

Historically, Southern red cedar was an important resource which attracted pencil factories to the region. Today, the remaining cedars are again beginning to reach a commercially harvestable size and can be considered a valuable, although reduced, resource (Wharton, et al., 1976).

Soil and Water Conservation and Flood Control

Because there are no major surface water drainage patterns on the site and because much of the drainage is internal, the forest communities at

the site currently do not play a significant role in "classical" flood control. However, the vegetative cover does provide important services in soil retention and erosion control in an area which already has very thin soils. The plant communities also are important in building up the soil layers through cycling of nutrients and production of organic humus. Carlisle, et. al. (1966), have shown that forest litter can account for 60 percent of internal nutrient input (phosphorus, potassium, calcium, magnesium) to the forest floor. Community type also has an effect on the amount of organic matter in the soil. Wells, et al. (1972), have found litter in hardwood stands to be 70 percent higher than that in pine stands. Odum (1960) found that although litter increased during the first years of field succession, the amount of organic matter in the topsoil actually declined.

Coastal hydric hammocks have been described as functioning as a buffer system between the estuary and the upland terrestrial systems (Wharton, et. al., 1976). During hurricanes and storm events, the hammocks reduce seawater flooding and velocity levels in inland areas. Conversely, the hammocks also reduce sudden influxes of fresh water (surface runoff due to high rainfall) into the estuaries, and thereby reduce salinity fluctuations.

Other Values

The site is not unique in its recreation and aesthetic value. Although the site does have some potential for hunting and wildlife observations, these activities are not now, and are not expected to be, permitted because of the proximity of the existing power plant complex. The forested areas do offer a visual buffer zone screening the appearance of the existing plants from some vantage points.

COMMERCIALLY AND RECREATIONALLY IMPORTANT SPECIES

Introduction

Important animal species of the proposed power plant site include game animals and resident fur-producing species. Common small game species of wildlife consist of bobwhite quail, mourning dove, cottontail rabbit, and grey squirrel. Populations of white-tailed deer and feral swine are present in much of the area and in some adjoining lands. The land seasonally attracts a few migratory species such as woodcock, common snipe, various ducks and rails. A wide variety of fur-bearing mammals can be expected to occur on the site. The definite status of some of these species within the project boundaries is unknown. The tree species historically or currently harvested in this area for forest products are slash pine and southern red cedar.

Plants

Slash Pine

Slash pine, the dominant tree species of on-site flatwoods and pine plantations, is a major pulp source in Florida (Knight and McClure, 1971). Within a 8-kilometer (5-mile) radius of the plant about 1,760 hectares or 4,350 acres (14 percent) are currently in pine plantation with another 1,800 hectares or 4,460 acres (14 percent) of slash pine flatwoods of potential timber value. Except for a few older "seed trees," the plantations and flatwoods on-site contain young trees from about 4 to 15 years old. Estimated pulpwood volume of the plantations at harvest is about 27 cords or 1,800 cubic feet (site index tables, Bennett and Clutter, 1968). Since tree density in the flatwoods is so great, timber potential is probably limited unless thinning occurs.

.

Southern Red Cedar

Historically, the southern red cedar has been logged from the coastal hammocks by pencil companies (Wharton, et al., 1976), but is also valuable for fence posts, panels, and other building supplies. Trees currently in the coastal hydric hammock on-site include those between 2.5 and 25 centimeters (1 to 10 inches) diameter at breast height (DBH), which could be suitable for some of these uses. In other communities on-site, the trees are generally less than 7 centimeters (3 inches) DBH and thus of little current value. Based upon an analysis of past growth rate, these trees, undisturbed, will reach a commercial size of 2.5 to 50 centimeters (1 to 20 inches) DBH in about 40 to 80 years.

Animals

Bobwhite Quail

The bobwhite quail occurs throughout Florida around cut-over country, forest fringes, and old fields. Quail populations in this area of Florida are fragmented because of insufficient acreage of quality habitat. There are, however, some sections of the proposed site which offer good habitat. The best habitat occurs in the disturbed pine flatwoods and near a few small fields. In these two habitats, two large coveys of bobwhite quail were sighted during the summer field survey. Within these areas a fairly good blend of escape, nest, brood, and forage cover exists. These quality habitats would seem short-lived unless understory vegetation is restricted. In addition, adjoining lands have recently been replanted to pine and presently offer good quail habitat.

White-Tailed Deer

The white-tailed deer occurs through the southeast and is abundant in much of Florida. The preferred habitat of deer is the brushy stages of

second-growth deciduous forest. Present conditions in the vicinity of the project are conducive to supporting some populations of deer. No deer were observed, but tracks were noted daily along most unimproved dirt roads. Present population levels appear to be moderate.

Squirrel

Three species of squirrel that can be expected to occur in the forest communities of Florida are: gray squirrel, fox squirrel, and southern flying squirrel. Of these three, only the gray and fox squirrel are significant as a hunting resource. The gray squirrel is an inhabitant primarily of mixed hardwoods whereas the fox squirrel generally prefers open woodlands and field/forest edges. Mesic and xeric hammocks in the area are reported to be the best quality habitat for gray squirrel, with hydric, coastal, and loblolly pine hammock next in importance (Florida Game and Fresh Water Commission, 1976). Most of these habitats are well represented on the site. Gray squirrels were sighted daily in many of these vegetative communities. The proposed site is considered poor habitat for fox squirrel.

Rabbit, Turkey, and Feral Swine

Apparently rabbit, turkey, and feral swine populations are not significantly large in the area. The major reasons for these depauperate populations include lack of suitable habitat, encroachment by man, land clearing for the purpose of development, and disjunct habitats.

Fur-Bearing Mammals

Fur-bearing mammals of western coastal Florida are opossum, raccoon, gray fox, river otter, mink, and bobcat. The opossum is common in nearly all wooded areas and coastal marshes. In mixed woodlands, raccoons prefer bottomlands for denning sites, and they forage over upland habitats and aquatic systems. Reported densities for opossums are 1 per

7.8 hectares (19 acres) in mixed swamp, while raccoons are 1 per 96.4 hectares (217 acres) in mixed swamp (Florida Game and Fresh Water Fish Commission, 1976). The gray fox is found more often in lowlands adjacent to dense bottomland forest. The bobcat is found primarily in hardwood bottomlands and swamps as well as in forested areas adjacent to these systems. Otter and mink are primarily riverine, swamp, or salt marsh species. Densities of gray fox, river otter, mink, and bobcat are poorly known for the area; however, Day (1973) reported densities of one mink and one otter per 16 hectares (40 acres) in a Louisiana salt marsh. It can be expected that most of these animals may occur on the site. Habitats are quite diverse and, it would appear, suitable to support relatively abundant populations.

2.7.3 AQUATIC ECOSYSTEM ANALYSIS

In the immediate vicinity of the proposed power plant site are three major aquatic-related habitat types: salt marsh, coastal hydric hammock, and freshwater marsh. The coastal zone is dominated by salt marsh. Within the salt marsh, Juncus roemerianus (black needlerush) and Spartina alterniflora (cordgrass) are the two principal floral types present. These grasses are of major importance in the initial link in any food web, primary production--the capture and conversion of energy from the sun to chemical-bond energy which, in turn, can be used by other organisms. There are two major food webs these grasses support; one involves those organisms which feed on the living plant (herbivores) and the second are those which feed on the detrital material produced by the plant (detritivores) (Keefe, 1972). The marsh also plays a major role as a nursery ground for fish and is an important habitat for various invertebrates, a major food source for some fish species.

Inland from the marsh there is a coastal hydric hammock system which is essentially freshwater-dominated. The principal flora in the area are live oak, southern red cedar, and cabbage palm. Here, freshwater invertebrates and insect larvae dominate the aquatic food chain which, in turn, supplements the diets of various terrestrial organisms. Farther inland, east of the western boundary of the proposed plant location and approximately 1,500 feet north of the existing power line corridor, is a series of freshwater marshes. These marshes support aquatic food webs similar to those of the hydric hammock. However, due to the ephemeral nature of these marshes, their long-term ecological importance is unclear. The freshwater marsh system encompasses 2.7 percent or 9.9 hectares (24 acres) of the proposed primary site area. The coastal hydric hammock comprises 52.1 hectares (128 acres) or 14.1 percent of the area. The salt marsh, containing 112.4 hectares (277.3 acres) or approximately 30.4 percent of the area, is approximately twice the combined area of freshwater marsh and coastal hydric hammock. The remaining acreage is pine flatwoods and other types of terrestrial habitats (see Section 2.7).

SALT MARSH

Flora

One of the major roles the wetlands have in any area is contribution to primary production. This contribution is accomplished via grasses such as Juncus roemerianus (black needlerush), which dominates the marsh in the Crystal River area, and Spartina alterniflora (cordgrass), which is located along the seaward edge and creekbanks of the marsh. Based on a 10-month study by Young (1975) in the Crystal River marsh system, the Juncus and Spartina standing crops are 540 grams (dry)/m² and 580 grams (dry)/m² respectively. Standing crop refers to the dry weight (biomass) of the species.

These values are well within the range expected, based on documented biomass values of these grasses in other areas (Keefe, 1972). A comparative study of Spartina standing crop was done by Young during the months of May and September at Jacksonville Electric Authority's Northside Generating Station. No significant differences were noted between the Crystal River site and the Jacksonville site for either month. In the Crystal River marsh system, the Spartina standing crop has a peak in August and a minimum value in February. Spartina begins flowering near the end of July or first part of August, and can continue to flower through the early part of November. The standing crop for Juncus, based on monthly values, varies between 420 and 540 grams/m² throughout the year. Gross production is defined as the increase in weight (net production) plus respiration. Respiration is defined as the energy required for maintenance activities. Over the same 10-month study period referenced earlier, these values for Juncus are 12.6 grams/m²/day and 4.6 grams/m²/day respectively. For Spartina, these values are 18.3 grams/m²/day for gross production and 3.5 grams/m²/day for respiration. During late winter/early spring, Juncus is the more productive of the two grasses. During the summer season, however, Spartina photosynthesis exceeds that of Juncus. Thus, both

grasses are important in maintaining a high productivity level in the marshes throughout the year.

These marsh grasses also play an important role as producers of detritus. Detritus is the organic remains of dead and broken grass parts (stems, blades, roots) and is a major source of nutrients for a number of organisms. Individuals which feed predominately on this detrital material are referred to as detritivores. Based on the same 10-month study by Young (1975), the combined detritus for these two grasses is 650 grams/m². The conversion rate of standing crop to detritus over a square meter of Spartina on a daily basis is 4.5 grams. For Juncus, the daily conversion is slightly higher (5.6 grams/m²).

Fauna

The species composition within the marsh is part of a highly complex system. This complexity and the variability in species diversity within the marsh is, in part, due to various physical interactions. Among these interactions are periodic inundation by saline water, input from freshwater sources, and periodic drops in water levels resulting in "dry land" [water depth at high tide averages .5 meters (Young, 1975)]. A further complication arises in the Crystal River area as a result of an existing thermal plume which inundates a portion of the marsh. The resident fauna have been placed subjectively into four categories, which are:

1. Terrestrial and brackish water microarthropoda;
2. Brackish and marine benthic macroinvertebrates;
3. Brackish and marine zooplankton; and
4. Brackish and marine fishes.

Table 2.7-12 describes the microarthropod population found in the vicinity of Crystal River marsh system. These organisms are important in the breakdown of detrital material and as prey for various carnivores. Detritivores numerically are the largest group in Spartina. Homoptera (cicadas, leafhoppers, and aphids) and Heteroptera, both of

Table 2.7-12 Microarthropods in the Vicinity of the Crystal River
Marsh System

Trophic Level and Order or Group

Herbivores

Orthoptera (grasshoppers, katydids, crickets, roaches, mantids,
walking sticks)

Heteroptera

Homoptera (cicadas, leafhoppers, aphids)

Thysanoptera (thrips)

Coleoptera (beetles, weevils)

Detritivores

Crustacea

Arachnida (mites)

Collembola (springtails)

Diptera (trueflies)

Carnivores

Arachnida (spiders, pseudoscorpions)

Hymenoptera (ants, bees, wasps, sawflies)

Source: Environmental Science and Engineering, Inc., 1977.

6/2/80

which are herbivores, and Hymenoptera (ants, bees, wasps, and sawflies) which are carnivores, are three specific orders that have been found to be statistically more abundant in Juncus marsh than in Spartina. Approximately .6 grams/m² of grass standing crop is used per day by insects (Young, 1975). Based on a 10-month study by McMahan (1975), herbivores make up a majority of the microarthropod community within the Juncus marsh. Unfortunately, McMahan reported his information and apparently reduced his data only as far as the taxonomic level of order, reducing the inter- and intra-descriptive capabilities of such samples and limiting the ability to reach any comprehensive conclusions. However, a few broad generalizations can be made. Both S (total species per sample) and S/1000 (species observed per 1,000 individuals present) have revealed statistically more numbers of microarthropods in Juncus than in Spartina marsh. The evenness index ($e = \text{Shannon-Weaver index of diversity} = H/\ln S$) showed a statistically more uniform distribution of species in Spartina marsh (McMahan, 1975), suggesting that the Spartina habitat supports a more balanced and diverse microarthropod community. This difference may be, in part, the result of the Spartina habitat being the more stable of the two systems, or at least less variable in terms of either biotic or environmentally induced stress.

Macroinvertebrates

The macroinvertebrate components of the marsh system can be broken down into three major categories:

1. Mollusca: Gastropoda;
2. Annelida: Polychaeta; and
3. Arthropoda: Decapoda.

These organisms are a major food source for other trophic levels. They also play a major role in the assimilation of the detrital material produced by the grasses. The estimated biomass for these organisms in the thermally influenced area is 16.3 grams/m², 92.5 percent of which is crabs, specifically Uca (Fiddler crab). In the unimpacted area, the biomass is 11.7 grams/m², of which 89.7 percent is crabs. A

comparative study of abundance of Littorina irrorata (gastropod; marsh periwinkle) and Uca sp. was conducted during the months of May and September at Jacksonville Electric Authority's Northside Generating Station. No significant differences were noted between the Jacksonville site and the Crystal River site for either month (Young, 1975).

Zooplankton

Zooplankton are microscopic, one-celled animals which are suspended in the water column. Larval forms of several larger organisms are temporarily members of the zooplankton community. Due to a lack of information on zooplankton within the marsh proper, the discussion on these organisms will be based on work done primarily by Cuzon du Rest (1963) on salt marshes of southern Louisiana and Maturo et al. (1974) on Crystal River estuarine systems.

The single most important zooplankton in Cuzon du Rest's work was the copepod Acartia tonsa which accounted for an average of 83 percent of those individuals counted. This organism has been a major component of the zooplankton community in several studies (Woodmansee, 1958; Hopkins, 1966; Maturo, et al., 1974). Acartia tonsa is both euryhaline and eurythermal, being found at temperatures from 5° to 35°C and at salinities of 0.3 to greater than 30 ppt. Decapod larvae including zoea and megalops of the blue crab were most abundant during the spring, though representatives from the group were obtained throughout the year. Combjellies and other ctenophores, which are zooplanktons, also are an apparently significant predator of zooplankton. Though taken throughout the year, highest concentrations were obtained during the summer months. Hallquist (1974) collected ctenophores throughout the year in the Crystal River estuary. Standing crops varied from .05 ml/m³ in the winter to 23.77 ml/m³ during the summer. No data was available for the fall. Hallquist concluded, during the time period he sampled, that "even under optimum feeding conditions, the ctenophore population at Crystal River was not large enough to have a significant effect upon zooplankton standing crop." Whether this point is valid in the

marsh system has yet to be determined. Many zooplankton appear to be primarily herbivorous filter feeders, ingesting the suspended organic matter in the water column which includes raw nutrients as well as food in the form of phytoplankton. Acartia tonsa appears to have two annual peaks in biomass—one in April and a smaller one in August. It has been estimated by Day (1973) that in Louisiana, A. tonsa has approximately ten generations per year, produces 20 grams of organic material/m²/year and respires 80.5 grams/m²/year. For the total zooplankton population, annual respiration is 100.6 grams/m² and production of organic material is 25 grams/m². In warmer waters, the number of annual generations may increase, resulting in increased values for production and respiration.

Percent-per-day production values for zooplankton in the nearby Crystal River estuary, based on work by Alden and Hearne (1974), produced seasonal averages of 10.9 percent, 9.8 percent, 14.6 percent, and 22.8 percent for fall, winter, spring, and summer, respectively. These values can be restated as the time period required for a turnover in biomass, and that in approximately 11, 10, 14.5, and 23 days for the various seasons, there is a turnover in the zooplankton biomass. Again, whether these values can be related to the marsh system adjacent to the proposed site is yet to be determined. McKellar (1975) determined zooplankton respiration in the Crystal River estuary on a per-unit body weight basis and found significant changes from winter to summer (0.006 grams/grams/day and 0.028 grams/grams/day, respectively).

Fish

Table 2.7-13 describes the various fish found in the Crystal River marsh system. Salt marshes may serve as nursery grounds for the juveniles and young of many species of fish (Harrington and Harrington, 1961)—not only commercial and recreational species such as the red drum, striped mullet, and black drum, but also various small fish important as prey for higher predators. Salt marsh tidal creek fish populations are influenced by the existing thermal plume. During the summer months, those creeks influenced by the thermal plume have been shown by McMahon (1975)

Table 2.7-13. Fish Previously Caught in the Crystal River Marsh Area

Species	Common Name
<u>Carcharhinus limbatus</u>	Blacktip shark
<u>Sphyrna tiburo</u>	Bonnethead
<u>Dasyatis sabina</u>	Atlantic stingray
<u>Lepisosteus oculatus</u>	Spotted gar
<u>Elops saurus</u>	Ladyfish
<u>Myrophis punctatis</u>	Speckled worm eel
<u>Brevoortia patronus</u>	Gulf menhaden
<u>Harengula pensacolae</u>	Scaled sardine
<u>Opisthonema oglinum</u>	Threadfin herring
<u>Anchoa hepsetus</u>	Striped anchovy
<u>Anchoa mitchilli</u>	Bay anchovy
<u>Synodus foetens</u>	Inshore lizardfish
<u>Arius felis</u>	Sea catfish
<u>Opsanus beta</u>	Gulf toadfish
<u>Hyporhamphus unifasciatus</u>	Halfbeak
<u>Strongylura marina</u>	Atlantic needlefish
<u>Strongylura notata</u>	Redfin needlefish
<u>Adinia xenica</u>	Diamond killifish
<u>Cyprinodon variegatus</u>	Sheepshead killifish
<u>Floridichthys carpio</u>	Goldspotted killifish
<u>Fundulus grandis</u>	Gulf killifish
<u>Fundulus similis</u>	Longnose killifish
<u>Lucania parva</u>	Rainwater killifish
<u>Gambusia affinis</u>	Mosquito fish
<u>Poecilia latipinna</u>	Sailfin molly
<u>Menidia beryllina</u>	Tidewater silverside
<u>Syngnathus floridae</u>	Dusky pipefish
<u>Echenis naucrates</u>	Sharksucker
<u>Caranx hippos</u>	Crevalle jack
<u>Oligoplites saurus</u>	Leatherjacket
<u>Selene vomer</u>	Lookdown
<u>Trachinotus falcatus</u>	Permit
<u>Lutjanus griseus</u>	Grey snapper
<u>Eucinostomus argenteus</u>	Spotfin mojarra
<u>Eucinostomus gula</u>	Silver jenny
<u>Eucinostomus letroyi</u>	Mottled mojarra
<u>Orthopristes chrysoptera</u>	Pigfish
<u>Archosargus probatocephalus</u>	Sheepshead
<u>Lagodon rhomboides</u>	Pinfish
<u>Bairdiella chrysura</u>	Silver perch
<u>Cynoscion nebulosus</u>	Spotted sea trout
<u>Leiostomus xanthurus</u>	Spot
<u>Pogonias cromis</u>	Black drum

6/2/80

Table 2.7-13. Fish Previously Caught in the Crystal River Marsh Area
(Continued, Page 2 of 2)

Species	Common Name
<u>Sciaenops ocellata</u>	Red drum
<u>Chaetodipterus faber</u>	Spadefish
<u>Mugil cephalus</u>	Striped mullet
<u>Mugil curema</u>	White mullet
<u>Mugil trichodon</u>	Fantail mullet
<u>Polydactylus octonemus</u>	Atlantic threadfin
<u>Bathygobius soporator</u>	Frillfin goby
<u>Gobiosoma robustum</u>	Code goby
<u>Microgobius gulosus</u>	Clown goby
<u>Scomberomorus maculatus</u>	Spanish mackerel
<u>Prionotus tribulus</u>	Big-headed sea robin
<u>Paralichthys albigutta</u>	Gulf flounder
<u>Achirus lineatus</u>	Lined sole
<u>Symphurus plagiusa</u>	Black cheek tonguefish
<u>Sphoerides nephelus</u>	Southern puffer
<u>Chilomyuterus schoepfi</u>	Striped burrfish

Source: Environmental Science and Engineering, Inc., 1977.

to have a biomass of 2.2 grams/m² and a numerical abundance of .46 individuals/m². These values represent 24 percent and 7 percent of the biomass and abundance of an uninfluenced marsh creek. During the colder months, an observed unaffected creek had a numerical abundance of .58 individuals/m², a 15 percent higher value than its thermally impacted counterpart. However, there was a 12 percent higher biomass during this same time period in the thermally influenced creek. The mean biomass for the uninfluenced creek over a 10-month study period was 8.3 grams/m² as opposed to 5.2 grams/m² in the heated creek. Mean abundances for the two creek types were 3.67 individuals/m² and .47 individuals/m², respectively. Based on these values, there appear to be fewer fish in the heated creek; however, those present apparently are larger than the fish in the uninfluenced creek.

The apparent biomass enhancement in fall and winter in the heated area may very well make up for the summer exclusion in terms of productivity, condition factors, and enhanced reproduction. The species responsible for the increased biomass were striped mullet, red drum, black drum, and sea catfish. Gulf killifish, longnose killifish, striped mullet, fantail mullet, spotfin mojarra, and tidewater silverside made up approximately 80 percent of the fish population in the unimpacted creek. Whether these were all juveniles or what percentage were juveniles was not specified. In the thermally influenced water body, the species were the same, with the exception of fantail mullet, which was replaced with black drum. A total of 55 species were observed in the uninfluenced creek, and 38 species in the thermally influenced creek.

Diversity indices for species have been developed to assist scientists in evaluating and comparing communities. The need for such devices results from the fact that all communities do not have the same number of species or number of individuals per species. A broad range of diversity indices have been developed in an attempt to overcome various shortcomings of previous mathematical descriptions. These indices range from merely counting the number of species to the popularized Shannon-Weaver function ($H = -\sum_{i=1}^s (p_i) (\log_2 p_i)$); where H is the index of species

diversity, S is the number of species, and p_i is the proportion of total samples belonging to i th species.

Margalef's theory is based on community maturity and the comparison of a "more mature" versus "less mature" system. The state of maturation of a given habitat can be described in terms of standing crop and energy relations such as food chain lengths and the ratio of production to biomass. The status of various populations within the community can also be ascertained based on the degree of fluctuations, life cycles, feeding relations, life span of individuals, and mechanisms for population control. Diversity indices given as species per 1,000 individuals and Margalef's diversity index $\frac{S-1}{\ln N}$ were lower for the thermally impacted creek. A general trend for both areas was a lower index in the winter, spring, and early summer, and a higher index during the late summer/fall period, which implies a more diverse group of fish with no single species or small group of species dominating the system.

Mid-carnivores, those individuals which prey on other organisms and, in turn, are preyed upon, are the dominant trophic level for the fish community from May through August, with herbivores dominating from October to January. Mid-carnivores also are of noticeable importance in the overall energy flow of the salt marsh tidal creek system at Crystal River.

Numerous authors (Reid, 1954; Springer and Woodburn, 1960; Sykes and Finucane, 1966; Carr and Giesel, 1975) have found that many of the young-of-the-year appear in estuaries during the spring and early summer months. At the Crystal River marsh site specifically, many of the juveniles appear during the summer months. Mugil cephalus (striped mullet) and Sciaenops ocellata (red drum), two important commercial species, arrive in late fall. The arrival time of Anchoa mitchilli (bay anchovy), Fundulus grandis (gulf killifish), and Sciaenops ocellata (red drum) deviated greatly between thermally impacted and unimpacted creeks. Bay anchovy juveniles were collected from June through October in the uninfluenced area, with most of these collected in July and

August. In the heated area, most of the juveniles of this species were collected in November, though juveniles continued to be sampled through February. The gulf killifish young arrived in the creeks from late spring until early fall. In the heated area, young of this species continued to appear through January. Red drum juveniles first appeared in the unheated area in October. In the thermal area, however, juveniles did not appear until January. These facts point out that there are deviations in the arrival time and species composition of fish in the affected and unaffected areas.

COMMERCIALY AND RECREATIONALLY IMPORTANT SPECIES

Below is a brief description of a few of the more "important" species. Importance was based on abundance and/or biomass ranking in the fish community, function as a commercial or recreational organism, importance as a potential food source, or having a limited habitat within the United States coastal waters.

Menidia beryllina (Cope) (Tidewater Silverside)

This species was the most abundant species collected by Homer (1975) and ranked second in total biomass in the thermally unimpacted creek. The species was never abundant in the thermally influenced creek. Over 90 percent of the total abundance and biomass of this species was obtained during the warm months. Springer and Woodburn (1960) determined M. beryllina to be among the most common and ubiquitous species in the Tampa Bay area. Carr and Giesel (1975), in their study at a power plant in Jacksonville, Florida, also found this fish to be the most abundant fish species in unheated waters, while thermally impacted waters had nominal numbers during the late summer months. Based on energy flow diagrams developed by Homer (1975), "The silverside provides food for many other fish and probably for many species of birds."

Pogonias cromis (Linnaeus) (Black Drum)

Pogonias cromis has never been found to be very abundant in the marshes of Florida. In Texas it is found most commonly in bays. Based on Homer's work (1975), this species was found in the unaffected creek in May, September, and December. In the thermally inundated creek, however, it was collected from July through October and ranked second in total biomass in this system.

Mugil cephalus (Linnaeus) (Striped Mullet)

The striped mullet supports west Florida's largest fin fishery and ranks second only to red snapper (Lutjanus aya) in dollar value (Homer, 1975); 75 percent of the total United States production of mullet is caught in Florida (Futch, 1966). Homer (1975) found this species to make up 36 percent of the total unimpacted creek fish biomass and 67 percent in the heated creek. However, the species exhibited a certain amount of avoidance of the impacted creek during the warm months. Springer and Woodburn (1960) collected this species during all seasons with the greatest abundance occurring during February through May. Juveniles were first noted in November. Sykes and Finucane (1960), working in the same area (Tampa Bay), observed a winter time period of juvenile mullet arrival (December through February). "Although no studies have been undertaken in Florida to gather quantitative data on mullet stocks, it is probable that marshes play an important role during various times of their life history" (Homer, 1975).

Mugil trichodon (Poeg) (Fantail Mullet)

According to Briggs (1958), this species occurs only along Florida's Gulf Coast, and in Bermuda and Brazil. Based on Homer's study (1975), M. trichodon enters the creeks by May and remains abundant in the non-heated creeks through December. "Virtually no fantail mullet were found in the thermally affected creeks during the warm months." It appears that thermal addition may have a detrimental effect on this

species. It is not known what contribution this species makes to the Florida mullet industry; however, more juveniles of this species were found in the marshes than juveniles of M. cephalus (Homer, 1975).

AQUATIC COMMUNITIES OF THE PROPOSED CONSTRUCTION SITE

The western boundary of the Florida Power proposed plant site encroaches into the coastal hydric hammock, which in turn is bordered by salt marsh on the west (Figure 2.7-2). Low areas within the freshwater marshes and within the hydric hammocks on the southern portion of the site also harbor seasonal aquatic communities. Here, the salt water intrusion and tidal influence are negligible, and the fresh water component, specifically ground water, is the prime influence. The creeks and small ponds have a litter-covered bottom and contain small fish and freshwater invertebrates (Table 2.7-14). The vegetation and wildlife of these communities are discussed in Section 2.7-2.

In order to characterize these on-site aquatic systems, Environmental Science and Engineering, Inc. (ESE) established aquatic sampling sites at the proposed plant location along the three north-south transects shown in Figure 2.7-8. Sampling on these transects occurred whenever a water body was encountered, with up to a maximum of five samples per transect. There were a number of water habitats found along the westernmost transect. Most of the systems appeared stagnant, based on visual observations; however, no water quality parameters were taken. Furthermore, there was no evidence of any surface water movement along this transect. All water systems at this transect appeared to have some life forms present, and the abundance of mosquitos demonstrated their use of the area as breeding grounds. Habitats sampled varied from marsh-like systems, to coarse sandy substrate ponds, to ponds partially filled with litter. Due to the extremely small numbers of organisms found, any statistical analysis would be inappropriate. Areas along two other transects had flora frequently associated with freshwater marshes (e.g., sawgrass, arrowhead, pickerel weed), although no standing water was observed on either transect. Terrestrial ecologists from ESE examined the site at a later date and noted numerous systems with water present in these general areas. For the most part, these systems were small ponds with a coarse clean sand substrate and few life forms evident.

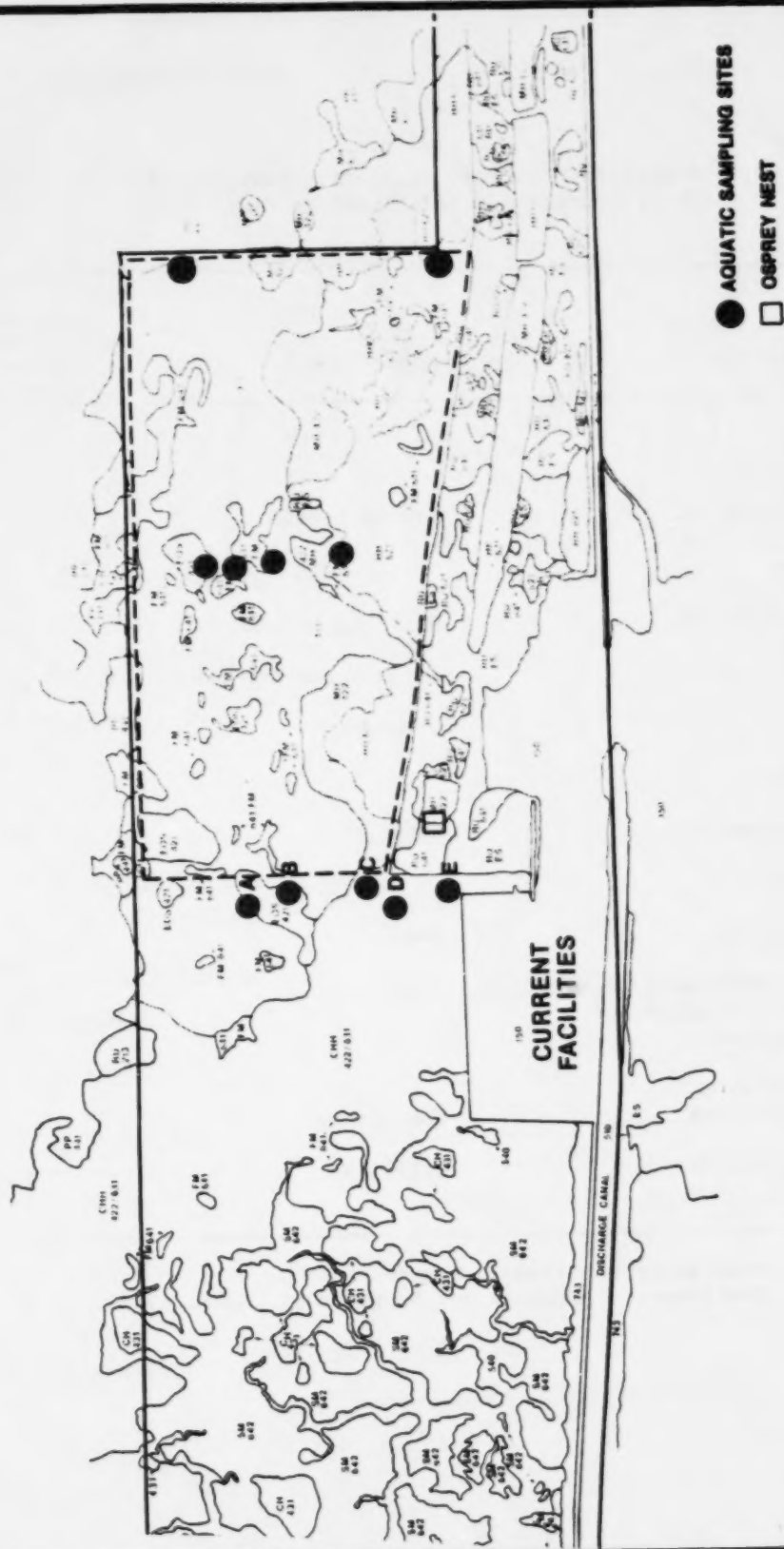
Table 2.7-14 Organisms Collected at Aquatic Sampling Stations Along
Three Transects at the Proposed Plant Site*

Scientific Name	Common Name	Total No. of Individuals Observed
Dytiscidae		
Cybister sp.	Diving beetle	1
Gyrinidae		
Dineutus sp.	Whirlgig beetle	3
Hydrophilidae	Water scavenger beetle	2
Odonata	Dragonfly	1
Oligochaeta		
Plesiopora	Worm	1
Gastropoda		
Physa sp.	Snail	1
Bivalvia (extremely small; identification not possible)	Clam	1 (3 empty shells)
Juvenile fish		
Poecillidae	Top minnow	
or		
Cyprinodont	Killifish	3

*All collected along westernmost transect.

Source: Environmental Science and Engineering, Inc., 1977.

Reproduced from
best available copy.



FLORIDA POWER CORPORATION
PROPOSED
CRYSTAL RIVER UNITS 4 & 5
CITRUS COUNTY, FLORIDA

Figure 2.7-8
LOCATION OF OSPREY NESTS AND AQUATIC SAMPLING SITES

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

2.7.4 RARE AND ENDANGERED SPECIES

INTRODUCTION

Rare and Endangered Species have been identified from both federal and state listings. The U.S. Fish and Wildlife Service publications include the existing listings (United States List of Endangered Fauna, 1974; Threatened Wildlife of the United States, 1973; Endangered and Threatened Wildlife and Plants, 1977) and the proposed listing (Proposed Endangered Status on Some 1700 U.S. Vascular Plant Taxa, 1976). The listings were updated as necessary through the use of successive notices in the Federal Register. One of these notices involved the deproposing of plant species. However, these plant species and their former proposed status have been retained in this discussion for informational purposes. State listings included those of the Florida Game and Freshwater Fish Commission (1974) and the Florida Committee on Rare and Endangered Plants and Animals (1976). The species which were identified from these sources have been defined by one or more of the following categories:

1. Endangered species (E)—those species in danger of extinction throughout all or a significant portion of their range;
2. Threatened species (T)—those species which are likely to become endangered in the foreseeable future throughout all or a significant portion of their range;
3. Rare species (R)—those species which are potentially at risk and should be monitored because of limited geographic ranges or sparse distributions (state listing only); and
4. Species of special concern (SC)—those species which should be monitored because of vulnerability to exploitation or environmental changes (state listing only).

PLANTS

Table 2.7-15 presents those rare and endangered plant species, including the advisory listing for Florida or those proposed for listing by the USFWS, that have been reported from Citrus County and its contiguous counties and possibly occurring in the vicinity of the plant site. The following paragraphs discuss the preferred habitats and likelihood of occurrence for each species.

Dwarf Spleenwort (State-Endangered)

Dwarf spleenwort, a tropical fern, reaches its northern limits in Florida, where small populations have been found only in eastern Citrus, Alachua, Marion, and Hernando counties. Found only in mesic and hydric hammocks, this species is adapted to deeply shaded limestone substrates (Florida Committee on Rare and Endangered Plants and Animals, 1976), and cannot tolerate removal of the forest cover. Although possible habitat does occur in the hydric and mesic hammocks, dwarf spleenwort was not observed during field surveys, and is not thought to occur on the proposed site.

Sink-Hole Fern (State-Endangered)

Another tropical fern, the sink-hole fern, has been found in only four locations in the United States; one sighting in Louisiana and three sightings in Florida. Although not reported for Citrus County, its presence in Alachua County to the north and Hernando County to the south indicates that it could occur on the proposed site (Florida Committee on Rare and Endangered Plants and Animals, 1976). Habitat consists of loamy soils over limestone in shaded moist hammocks (Wherry, 1964). Although not sighted, potential habitat does occur in the various hardwood hammocks on the site.

Table 2.7-15 Rare and Endangered Plant Species Reported in the Crystal River Region

Species	Common Name	Status		Citrus County	Reported Occurrence		Habitat
		FCRPA*	UDTY		Contiguous Counties**		
<u>Asplenium pumilum</u>	Dwarf spleenwort	E	—	X			Calcareous rock—moist hammocks
<u>Blechnum occidentale</u>	Sink-hole fern	E	—		X		Deep-shaded ravines & sinkholes
<u>Dicerandra frutescens</u>		—	E		X		Deciduous oak sandhills
<u>Sum Floridaeum</u>	Water Parsnip	—	E		X		Mixed swamps & flooded areas
<u>Zamia integrifolia</u>	Coontie	T	E	X			All hammock & deciduous oak sandhills
<u>Rhapidophyllum hystrix</u>	Needle palm	T	T		X		Swamps & moist hammocks
<u>Smilax smallii</u>	Jackson-vine	T	—		X		Mixed swamp/bayheads
<u>Isoetes Flaccida</u>	Quillwort	—	T	X			Moist areas & swamps
<u>Persea humilis</u>	Silkbay	—	T		X		Sand pine & deciduous oak sandhills
<u>Adiantum capillus-veneris</u>	Venus-hair fern	R	—	X			Mixed swamp & moist calcareous hammocks
<u>Drosera intermedia</u>	Water sundew	R	—	X			Ponds & bogs
<u>Eriogonum Floridaeum</u>	Scrub buckwheat	R	—		X		Dry sandy pinelands
<u>Hartwrightia Floridaeum</u>	Hartwrightia	R	T		X		Swamps—North Florida
<u>Leitneria Floridaeum</u>	Corkwood	R	—	X			Sawgrass marshes along rivers
<u>Liatris provinciales</u>	Godfrey's blazing star	R	E		X		Coastal sands—dry pinelands
<u>Litsea aestivalis</u>	Pond spice	R	T		X		Pond & swamp margins, woodlands
<u>Salix Floridaeum</u>	Florida willow	R	E		X		Moist calcareous hammocks & swamps
<u>Vicia ocalensis</u>	Ocala vetch	R	E		X		Fields, roadsides, pine flatwoods

* Florida Committee on Rare and Endangered Plants and Animals, 1976 (advisory listing only).

† United States Department of Interior—Proposed Endangered Status on Some 1,700 U.S. Vascular Plant Taxa, 1976 (all species on table have since been deproposed).

** Marion, Levy, Suñter, and Hernando counties.

Sources: Florida Committee on Rare and Endangered Plants and Animals, 1976.

United States Department of the Interior, 1976.

Environmental Science and Engineering, Inc., 1980.

Dicerandra (Federal-Endangered)

The mint, Dicerandra, is endemic to the deciduous oak sandhills of the relic dunes of the central Florida ridge in Highlands and nearby Marion counties (Florida Game and Fresh Water Fish Commission, 1976). Suitable habitat does not occur on the proposed site; therefore, it is doubtful this species ranges into western Citrus County.

Water Parsnip (Federal-Endangered)

Water parsnip has been reported in Leon, Levy, Marion, and Putnam Counties in areas such as swamps, flooded areas, and muddy waters (Florida Game and Fresh Water Fish Commission, 1976). The clear marshes with hard, clean bottoms on the site probably are very poor habitat for this species.

Coontie (Federal-Endangered)

The fairly widely distributed coontie is the only species listed which was found during field surveys of the site. This member of the primitive cycad family was used as a food source by the Seminole Indians (Long and Lakela, 1971).

Occurrence of the coontie on the site is occasional, with scattered individuals located in the mesic, hydric, and coastal hydric hammocks. On-site density may be relatively low on a regional level, since numerous individuals were also observed in the coastal hydric hammocks south of the property, at the archaeological museum near Crystal River, and in xeric hammocks to the east of the site. The Florida Game and Fresh Water Fish Commission reports that the coontie is common to abundant in mesic, xeric, and coastal hammocks and in sandhills throughout the coastal part of the state.

Venus-Hair Fern (State-Rare)

The venus-hair fern has been reported for Citrus and surrounding counties, where it may occur in low numbers and small colonies (Florida Game and Fresh Water Fish Commission, 1976). Preferred habitat of the

venus-hair fern includes damp limestone rocks or, occasionally, muck soils in hardwood hammocks and swamps (Cobb, 1963; Florida Game and Fresh Water Fish Commission, 1976). Although suitable habitat occurs on-site, this distinctive fern was not found during field surveys. On-site soils may be too acidic or saline for the venus-hair fern and thus may preclude it from an otherwise suitable habitat.

Water Sundew (State-Rare)

Water sundew occurs throughout central Florida and the panhandle, as well as in Citrus County where it is locally abundant in marshes and ponds in the vicinity of Lake Rousseau (Florida Game and Fresh Water Fish Commission, 1976). However, water sundew was not located through intensive searching during field surveys conducted on the site or in drainage ditches and marshes in the vicinity of the site. Therefore, this small insectivorous plant probably does not occur on-site.

Quillwort (Federal-Threatened)

Quillwort belongs to a family related to the ferns and the horsetails and is generally considered to be a primitive form of vascular plant (Cobb, 1963). Occurring throughout central Florida, quillwort has been found in an ash swamp south of the Withlacoochee River in Citrus County (Florida Game and Fresh Water Fish Commission, 1976). This species may occur in the calm waters or edges of the hammocks and freshwater marshes on the property.

Silkbay and Scrub Buckwheat (Federal-Threatened)

Endemic to the evergreen oak-sand pine scrub and deciduous oak sandhills of the Central Florida Ridge area east of Ocala in Marion County, the range of silkbay and scrub buckwheat extends from Putnam County southward (Kurz and Godfrey, 1962). Although small areas of evergreen oak scrub occur on-site, the sands probably are not sufficiently deep, and therefore, the occurrence of these species on-site is unlikely.

Needle Palm and Hartwrightia (Federal-Threatened)

Needle palm and hartwrightia are found in swamps and mesic hammocks throughout north central Florida from Clay to Brevard counties and have been reported in eastern Marion County (Florida Game and Fresh Water Fish Commission, 1976). It is unlikely that these species occur on the site because of the distance from their centers of distribution. Although potentially suitable habitat was noted, neither species was identified on the Florida Power property.

Jackson-Vine (State-Threatened)

Jackson-vine occurs mainly in north central Florida and the panhandle, from Marion County to Okaloosa County, in its preferred habitats of mixed swamp, floodplain, forest, and bayheads (Radford, et al., 1968). The wetland forests on the site do not correspond exactly to these preferred habitats although there could be a potential for occurrence of Jackson-vine on the property.

Corkwood (State-Rare)

The corkwood is a small tree which inhabits sawgrass marshes bordering Gulf Coast rivers and streams as far south as the Gulf Hammock area of Levy County. Suitable habitat for this species probably does not exist on the site.

Godfrey's Blazing Star (Federal-Endangered)

Suitable habitat does not occur on the site. This species is restricted to sandy coastal soils such as beaches and dunes along the west coast of Florida.

Pond Spice and Florida Willow (Federal)

The preferred habitats of pond spice (Threatened) and Florida willow (Endangered) are pond and swamp margins and low, wet woodlands. Such habitats do occur on the site and, therefore, either species may occur on-site.

Ocala Vetch (Federal-Endangered)

Ocala vetch, a legume, has been found in isolated areas near Ocala in Marion County. It is not expected to occur as far west as the site.

ANIMALS

Today there are approximately two hundred animals that are considered either endangered or threatened by human activities such as habitat destruction, competition from introduced species, pesticides, and other forms of human interference. The following analysis is based on direct observations, habitat association analysis, and literature sources.

General references used were Rare and Endangered Plants and Animals from the Cross Florida Barge Canal Restudy Report (Florida Game and Fresh Water Fish Commission, 1976) and Florida Committee on Rare and Endangered Plants and Animals (1977) unless otherwise stated. Of the 34 animal species listed, 6 rare or endangered species were sighted during the 1977 field survey. Most of these species were listed on the advisory state list only. The following discussion presents a brief analysis of status and likelihood of occurrence for each of the 34 species, as shown in Table 2.7-16. Of these 34 species, nine are currently on Federal Endangered or Threatened Species Lists.

Short-Tailed Snake (State-Endangered)

The range of the short-tailed snake is confined entirely to peninsular Florida from Highlands County to Columbia County. This species occurs chiefly in longleaf pine/turkey oak forest associations and infrequently in upland oak forests. The short-tail snake is a burrowing animal, seldom present above ground except during the spring and fall. Encroachment by man into preferred habitat is the greatest threat to this species. In some instances, thermal stress caused by removal of overstory in sandhill communities has destroyed certain populations of the short-tailed snake (Campbell, 1975). The forest associations normally inhabited by this species are not present on the proposed site.

Table 2.7-16 Rare and Endangered Animal Species Which May Occur in the Vicinity of the Crystal River Property

Species	Common Name	Status*			Preferred Habitat	Likelihood of Occurrence
		FOREPA	USDI	FCMFC		
Amphibians and Reptiles						
<u>Notophtalmus perstriatus</u>	Striped newt	R	—	—	Pineflats & sandhills, ponds	Likely
<u>Rana areolata aesopus</u>	Florida gopher frog	T	—	T	Fields, sandhills, xeric hammocks	Likely
<u>Chrysomys concinna</u>	Swamnee cooter	T	—	T	Fresh-brackish rivers & spring runs	Marginal
<u>Gopherus polyphemus</u>	Gopher tortoise	T	—	T	Fields, sandhills, xeric hammocks	Present
<u>Stilosoma extenuatum</u>	Short-tailed snake	E	—	E	Longleaf pine, turkey oak	Marginal
<u>Drymarchon corais couperi</u>	Eastern indigo snake	T	T	T	Fields, sandhills, xeric hammocks	Present
<u>Alligator mississippiensis</u>	American alligator	T	T	E	Ponds & marshes	Present
Birds						
<u>Pelecanus occidentalis</u>	Brown pelican	T	E	T	Estuary & Lake & salt marsh	Present
<u>Florida caerulea</u>	Little blue heron	SC	—	—	Coastal hammock, fresh & salt marsh	Present
<u>Casmerodius albus</u>	Great egret	SC	—	—	Salt marsh & fresh marsh	Likely
<u>Egretta thula</u>	Snowy egret	SC	—	—	Estuary, salt & fresh marsh	Present
<u>Hydranassa tricolor</u>	Louisiana heron	SC	—	—	Estuary, salt & fresh marsh	Likely
<u>Nycticorax nycticorax</u>	Black-crowned night heron	SC	—	—	Coastal hammock, fresh & salt marsh	Likely
<u>Nyctanassa violacea</u>	Yellow-crowned night heron	SC	—	—	Coastal hammock, fresh & salt marsh	Likely
<u>Nycteria americana</u>	Wood stork	E	—	E	Swamps, ponds, marshes	Likely
<u>Eudocimus albus</u>	White ibis	SC	—	—	Wetlands	Likely
<u>Accipiter cooperii</u>	Cooper's hawk	SC	—	—	Secluded woodlands	Likely
<u>Buteo brachyurus</u>	Short-tailed hawk	R	—	—	Field/woodland ecotones	Likely
<u>Haliaeetus leucocephalus</u>	Southern bald eagle	T	E	E	Shores of large water bodies	Likely
<u>Pandion haliaetus</u>	American osprey	T	—	—	Shores of large water bodies	Present
<u>Falco carolinensis</u>	Peregrin falcon	E	E	E	Coastal areas	Marginal
<u>Falco sparverius paulus</u>	Little kestrel	T	—	—	Open fields & pinewoods	Likely
<u>Haematopus palliatus</u>	American oystercatcher	T	—	T	Spoil islands, berms, flats	Likely
<u>Charadrius melodus</u>	Piping plover	SC	—	—	Spoil islands, berms, flats	Likely
<u>Quadrarius alexandrinus</u>	Snowy plover	SC	—	—	Spoil islands, berms, flats	Likely
<u>Sterna albigifrons</u>	Least tern	T	—	T	Spoil islands, berms, flats	Present
<u>Sterna maxima</u>	Royal tern	SC	—	—	Spoil islands, berms, flats	Likely
<u>Sterna caspia</u>	Caspian tern	SC	—	—	Spoil islands, berms, flats	Likely
<u>Sterna sandvicensis</u>	Sandwich tern	SC	—	—	Spoil islands, berms, flats	Likely
<u>Nynchops niger</u>	Black skimmer	SC	—	—	Spoil island, berm, flat, estuary	Present

Table 2.7-16 Rare and Endangered Animal Species Which May Occur in the Vicinity of the Crystal River Property
(Continued, page 2 of 2)

Species	Common Name	Status*	FOREPA	USDI	FGWFC	Preferred Habitat	Likelihood of Occurrence
<u>Dendrocopos villosus</u>	Southern hairy woodpecker	—	SC	—	—	Pinewoods, swamps, & hammocks	Likely
<u>aukibonii</u>	Red-cockaded woodpecker	E	E	—	—	Mature pine flatwoods	Marginal
<u>Dendrocopos borealis</u>	Florida scrubjay	—	T	—	—	Oak scrub	Marginal
<u>hylosomus</u>	Marian's marsh wren	—	SC	—	—	Salt marsh	Likely
<u>Arremonops coeruleascens</u>	Florida prairie warbler	—	SC	—	—	Coastal hammock and mangroves	Marginal
<u>coeruleascens</u>	Worm-eating warbler	—	SC	—	—	Hardwood forest	Marginal
<u>Telmatorhynchus palustris</u>	Bachman's warbler	E	E	—	—	Hardwood swamp	Marginal
<u>marianae</u>	Kirtland's warbler	E	E	—	—	Pine woodlands	Marginal
<u>Dendroica discolor</u>	Louisiana seaside sparrow	—	T	—	—	Salt marsh	Likely
<u>paludicola</u>	Scott's seaside sparrow	—	SC	—	—	Salt marsh	Likely
<u>Helminthophila vermivorus</u>	American redstart	—	SC	—	—	Hardwood swamp and hammocks	Present
<u>Vermivora bachmani</u>							
<u>Dendroica kirtlandii</u>							
<u>Amospiza maritima fisheri</u>							
<u>Amospiza maritima</u>							
<u>peninsulæ</u>							
<u>Setophaga ruticilla</u>							
Mammals							
<u>Sorex longirostris</u>	Southeastern shrew	—	R	—	—	Floodplain forests & swamps	Likely
<u>longirostris</u>	Houassassa shrew	—	R	—	—	Floodplain forests & swamps	Likely
<u>Eptesicus fuscus</u>	Big brown bat	—	R	—	—	Open areas	—
<u>Plecotus rafinesquii</u>	Southeastern big-eared bat	—	R	—	—	Forested hammocks	Likely
<u>Sciurus niger shermani</u>	Sherman's fox squirrel	—	T	—	—	Open pine flatwoods	Present
<u>Peromyscus floridanus</u>	Florida mouse	—	T	—	—	Variable	—
<u>Ursus americanus</u>	Florida black bear	—	T	—	—	Large forest expanses	Likely
<u>Florida</u>	Florida weasel	—	R	—	—	Variable	Likely
<u>Mustela frenata peninsulæ</u>	Florida mink	—	R	—	—	Salt marsh	Likely
<u>Mustela vison lufensis</u>	Florida panther	E	E	—	—	Large forest expanses	Marginal
<u>Felis concolor coryi</u>							

* Status categories for listed species are based on the following sources: FOREPA (Florida Committee on Rare and Endangered Plants and Animals); USDI (U.S. Department of the Interior); and FGWFC (Florida Game and Fresh Water Fish Commission).

Sources: Florida Committee on Rare and Endangered Plants and Animals, 1976.

U.S. Department of the Interior, 1977.

Florida Game and Fresh Water Fish Commission, 1977.

Environmental Science and Engineering, Inc., 1977.

Suwannee Cooter (State-Threatened)

The Suwannee cooter is found only in Florida and is restricted to rivers and spring runs on the Gulf of Mexico. The optimum habitat is in fresh to brackish water with abundant submergent vegetation. Currently, there is very little suitable habitat at the proposed site.

Gopher Tortoise and Commensals (State-Threatened)

The gopher tortoise is locally distributed in the Coastal Plain from South Carolina and Florida to eastern Louisiana. In Florida, the gopher tortoise may be encountered widely in northern sections with scattered populations occurring in suitable habitats in the south. Preferred habitat consists of old field areas, longleaf pine sandhill, live oak hammock, and beach scrub, usually with abundant herbaceous cover of several types. A few burrows may occur in maintained pastures, mixed swamp, mesic hammock, pine flatwoods, or scrub, but generally these habitats are not utilized. Some important burrow symbionts which may occur in these same habitats include the pine snake, indigo snake, Florida mouse, and Florida gopher frog. Other commensals include a large number of invertebrates, eastern diamondback rattlesnake, and various mammals. In xeric habitats (e.g., scrub, xeric hammock, and sandhills) the loss of gopher tortoise burrows as a refuge and hibernacula could adversely effect commensal organisms. Reasons for decline of the gopher tortoise population include destruction of habitat, fire prevention, unfavorable alteration of habitat by forestry, collection for food or for pet trade, and possibly the practice of introducing gasoline into gopher burrows to drive out snakes.

Because of the dense ground cover vegetation and the paucity of preferred habitat, quantitative inventories were not attempted. However, qualitative random searches were employed in the most suitable habitats. A total of eight active tortoise burrows were found, six in scrub oak and two in early successional communities. In addition, two gopher tortoises were encountered, one in pine flatwoods and one on an unimproved dirt road crossing an oak scrub community. All scrub oak communities

which contained active gopher tortoise burrows were located within the pine flatwoods. The two burrows in early successional communities were found within the power line corridor. Commensal organisms recorded on-site consisted of the eastern diamondback rattlesnake, indigo snake, and Florida mouse.

Striped Newt (State-Rare)

The striped newt is found in southeastern Georgia and northern Florida. Adult and larval stages occur in pine flatwood and sandhill ponds and the eft stage occurs in well-drained sandy areas. No newts were encountered at the site; however, there is habitat for adults and larval forms in some ponds in the pine flatwoods and for the eft stage in well-drained portions of the flatwoods. Draining and filling of flatwood ponds contribute to the scarcity of this animal.

American Alligator (Federal-Threatened)

The American alligator inhabits marshes and swamps throughout the coastal states in the southeast and occurs regularly in Citrus County, particularly Lake Rousseau. Two alligators were sighted in the fly ash pond at the Florida Power plant site and it is likely that alligators also use the swamp and pond habitats in the vicinity. Surveys indicate that there are no large numbers of alligators in the area of the proposed site. General protective measures for the alligator include increased enforcement of anti-poaching laws and preservation of wetland habitats. Currently, stream channelization, drainage of wetlands, and other drastic alterations of natural waterways constitute the major limiting factors.

Eastern Indigo Snake (Federal-Threatened)

The eastern indigo snake occurs locally in peninsular Florida, in a few widely scattered areas of the Georgia Coastal Plain, and in parts of the Florida panhandle. This snake occupies a wide variety of habitat types. In xeric habitats, the shelter provided by gopher tortoise burrows apparently constitutes a critical factor for the survival of this snake.

Because of the diversity of habitat and the large population of rodents on the site, the proposed site area is considered good habitat. One indigo snake has been observed in the mesic hammock (Voigts, 1977). As with other animals associated with tortoise burrows, the snake collectors' practice of pouring gasoline into these burrows may have deleterious effects on this snake. In addition, clearing of forest lands for development, replanting to pine, or other uses contribute to the scarcity of the eastern indigo snake.

Eastern Brown Pelican (Federal-Endangered)

Formerly a common bird over much of the southern Atlantic coast, the Eastern Brown Pelican currently has an apparent sustaining population only in Florida. Two major colonies occur near the proposed plant site, one on Seahorse Key and the second on Bird Key in Citrus County. The brown pelican is primarily a marine species with only occasional occurrence in freshwater systems. It is expected that the brown pelican will not occur on the plant site, but may frequent adjacent salt marshes and Lake Rousseau. Decline of this species is probably related to eggshell thinning due to accumulation of pesticides in the aquatic food chain (Blus, et al, 1971).

Little Blue Heron, Snowy Egret, Great Egret, Louisiana Heron, Black-Crowned Night Heron, Yellow-Crowned Night Heron, and White Ibis

Any of these species may occur in various aquatic habitats in the vicinity of the Crystal River Power Plant (see Table 2.7-10). Because of their close association with aquatic habitats and the declining number of these systems, populations of these species are of special concern.

Wood Stork (State-Endangered)

The wood stork is locally common in southern swamps, freshwater marshes, and ponds. The only nesting colonies of wood stork occur in Florida; however, there are no confirmed rookeries located in the vicinity of the proposed power plant. Suitable nesting and roosting habitat occur in the coastal hammock of the site. Human encroachment and habitat destruction constitute the greatest threat to the wood stork.

Peregrine Falcon (Federal-Endangered)

Although the peregrine falcon is quite rare, it is an occasional winter resident in Florida, principally inhabiting coastal areas. Due to the scarcity of this bird, it is unlikely that it would occur on-site. Reasons for the population decline are related to poisoning and inhibition of reproduction by pesticides, nest molestation, and shooting.

Red-Cockaded Woodpecker (Federal-Endangered)

The red-cockaded woodpeckers' present range extends throughout much of the southern Atlantic and Gulf states. This woodpecker, which is indigenous to pinelands, usually nests and roosts in mature longleaf pine flatwoods. Nests usually are constructed in living pines infected with a fungal disease known as "red heart." Pine flatwoods on-site currently are not mature enough for habitation by the red-cockaded woodpecker, nor is there any observed incidence of red heart disease. The decline of this species is due to its specialized habitat requirements which conflict with current widespread forestry practices such as intensive even-aged management in pine forest and culling of substandard trees. If nest trees are left undisturbed, the red-cockaded woodpecker may survive.

Southern Bald Eagle (Federal-Endangered)

In the southeast, the southern bald eagle nests primarily in the estuarine areas of the Atlantic and Gulf coasts and along the lower Mississippi Valley. Wintering populations frequently are found along estuaries, rivers, and near lakes. No nests were observed on the proposed power plant site, although they do occur in the vicinity. One mature eagle was observed hunting for fish at Lake Rousseau. Pesticides, illegal shooting, and human disturbance have caused the decline in population of the bald eagle.

American Osprey (State-Threatened)

The American osprey is abundant along the coastal area of Crystal River. Ospreys were seen in the estuaries of Crystal River and are likely to be

found on the site of the proposed power plant. One nest which was sighted apparently was active the preceding spring (Figure 2.7-8). The primary cause for decline of the American osprey is pesticide poisoning.

Little Kestrel and Florida Scrub Jay (State-Threatened)

Both of these species are known to occur in the vicinity of Crystal River. The kestrel is oriented to open field or open pine forests. The scrub jay is restricted to oak scrub communities. Likely habitat for the kestrel is found along the power lines at the Florida Power power plant site. Preferred habitat for the scrub jay is limited on the site; however, there is some scrub oak associated with the pine flatwoods. Neither of these birds was observed at the proposed site.

Piping Plover, Snowy Plover (Special Concern), and American Oystercatcher (State-Threatened)

These shorebirds are restricted primarily to beaches, mudflats, and spoil islands. It is unlikely that they will occur in proximity to the proposed site. However, they may be encountered in adjoining estuaries and various spoil islands along the coast. Habitat loss through intensive human use of beaches and other coastal environments may have deleterious effects on local populations of these birds.

Seaside Sparrows and Marian's Marsh Wren (State-Special Concern)

Various seaside sparrows and the Marian's marsh wren occur in the salt marshes of Florida. Likely habitat occurs in the salt marsh adjacent to the proposed power plant. The greatest threat to these species is exploitation and destruction of coastal habitats.

Short-Tailed Hawk (State-Rare)

This hawk occurs throughout peninsular Florida as far north as the lower Suwannee River, middle St. Johns River, and in coastal portions of the panhandle. Suitable nesting and roosting areas, which are usually in woods adjacent to open prairies or marshlands, include mature cypress, riparian hardwoods, mangrove or pines. Likely habitat occurs at the

site, particularly along the coastal hammock/salt marsh ecotone. Destruction of riparian hardwoods and mature cypress could seriously reduce nesting habitat for this hawk.

Cooper's Hawk (State-Special Concern)

The Cooper's hawk is an uncommon permanent breeding resident throughout Florida, with most birds occurring in the northern half of the state. This hawk nests in secluded woods, more often in pine than hardwood. It is likely to occur in pine, oak, pine hardwoods, and the edges of other woods. Suitable nesting and roosting habitat occurs in the various forest types on the site. This hawk feeds primarily on birds, and its numbers have been decreasing, apparently because of the widespread use of pesticides.

Least Tern (Threatened), and Sandwich Tern, Caspian Tern, Royal Tern, and Black Skimmer (State-Special Concern)

The royal tern, sandwich tern, and black skimmer are year-round residents of Florida. The least tern is a summer resident, and the Caspian tern is a winter resident. All these species, except the Caspian tern, have rookeries located on offshore spoil islands near the project area. Fifteen black skimmers were sighted in the fly ash disposal pond. Common terns and least terns were observed in the estuarine system near the plant site. Reasons for the decline of these species are development of rookery areas, continued disturbance of nesting habitat by man, and degradation of bays and estuaries.

Southern Hairy Woodpecker (State-Special Concern)

The range of the southern hairy woodpecker extends throughout Florida in a variety of habitats. Major habitats utilized include pinelands, deciduous swamp hammocks, and cypress stands. There is suitable habitat at the site and this subspecies is likely to occur. The reasons for the scarcity of this woodpecker in Florida are uncertain; however it is probable that large scale destruction of mature forest is a contributing factor.

Florida Prairie Warbler (State-Special Concern)

The Florida prairie warbler breeds in the Florida Keys, north to Volusia County and on the Gulf Coast to Levy County. Mangroves are typical habitat, but some numbers are found in coastal hammocks. Although no specimens were observed, suitable habitat occurs in the various hammocks.

Worm-Eating Warbler (State-Special Concern)

The worm-eating warbler is found throughout much of the eastern United States. In this area of Florida, it occurs mainly as a rare transient. Because this bird may be expanding its breeding range southward into Florida, it is listed as a Species of Special Concern.

Bachman's Warbler (Federal-Endangered)

The Bachman's warbler occurs erratically in the river swamps of the southeastern United States. Nesting sites usually are heavily timbered swamps with dense undergrowth, including cane and palmetto. Because of the scarcity of this species, it is unlikely that it would occur in the project area. Reasons for its decline are obscure but may include extensive lumbering of bottomland swamps.

Kirtland's Warbler (Federal-Endangered)

Kirtland's warbler may occur as a very rare spring or fall transient throughout the southeastern United States. This warbler apparently breeds only in a restricted area of jack pine forest in southern Michigan (U.S. Department of the Interior, 1973). Winter habitat is confined to pinewoods, broadleaved scrub, and Australian pine. This species should be considered accidental in Florida and may occur rarely in the Crystal River area during migration.

American Redstart (State-Special Concern)

The American redstart has been observed throughout Florida. It prefers second-growth deciduous forests for nesting, with migrants occurring in mixed hardwood swamps, live oak hammocks, and cabbage palm hammocks. This species was sighted in a mesic hammock on the proposed site. The

American redstart is listed as a Species of Special Concern because of its limited breeding range in Florida.

Florida Panther (Federal-Endangered)

The Florida panther is now restricted primarily to Florida with other small populations occurring along some large swamp/river systems in various parts of the southeast. Recent sightings have occurred in Alabama (Endangered and Threatened Plants and Animals of Alabama, 1976) and individuals have been observed in the vicinity of Valdosta, Georgia (Louman, 1975) and the Okefenokee Swamp (Belden, 1977). In Florida, Layne (1974) included the following counties as having valid reports: Dade, Broward, Palm Beach, Collier, Glades, Hendry, Highlands, Manatee, Pinellas, Martin, St. Lucie, Brevard, Polk, Levy, Alachua, Duval, Walton, and Sarasota.

The panther may be found in a variety of terrestrial habitats, although it prefers large unbroken tracts of land. This subspecies could occur along the continuous coastal hammock of western Florida. Man is the major limiting factor to this animal.

Sherman's Fox Squirrel (State-Threatened)

The range of the Sherman's fox squirrel is limited to peninsular Florida and possibly southeastern Georgia. Open pine flatwoods seem to be the most frequently used habitat, but sand scrub, longleaf/deciduous oak, bayheads, sandhills, and borders of cypress swamps are also used. Although no individuals were observed on the site, one road kill was collected on State Highway 44 approximately 14 kilometers (9 miles) east of Crystal River. This section of road is bordered by a deciduous oak sandhill community. Although optimum habitat is not found at the site, fox squirrels may inhabit some pine flatwoods and various field-forest ecotones. The destruction of primeval pine forest by loggers is probably the greatest cause for the decline of this animal.

Florida Black Bear (State-Endangered)

Originally the Florida black bear ranged throughout Florida. Present populations are centered mainly in Apalachicola, Osceola, and Ocala National Forests, with remnant populations occurring in various parts of the state. According to Hamilton (1943), secluded swamps and forests are areas of preferred habitation for bears. The Cross Florida Barge Canal Restudy Report (Florida Game and Fresh Water Fish Commission, 1976) cited the probable occurrence of one bear in the vicinity of Inglis, Florida. It is not unlikely that bears may occur in the area of the proposed site. As the densely forested areas of Florida are being utilized increasingly by man, the status of the Florida black bear becomes more uncertain.

Southeastern Shrew (State-Rare)

This shrew is found in parts of 15 states, mainly east of the Mississippi River, from Illinois to Alabama and northern Florida. In Florida, this subspecies has been reported from various localities, including Homossassa Springs and Citrus County (Davis, 1957). The preferred habitat of the southeastern shrew is river floodplains and swamps, especially annually flooded areas with an abundance of fallen, decaying logs and thick understory vegetation. This shrew is likely to occur in some areas of the site, especially in the more moist situations. The destruction of preferred habitat is the greatest danger to the southeastern shrew.

Homossassa Shrew (State-Rare)

This shrew is known to occur only in the vicinity of Homossassa Springs in Citrus County, Florida. Preferred habitat is the floodplain forest associated with the Homossassa River. The Homossassa shrew is unlikely to occur in the project area; however, there is suitable habitat currently. Reduction of habitat by channelization of streams and drainage of swamps is the greatest threat to this species.

Big Brown Bat (State-Rare)

The big brown bat ranges from northern South America, including the Caribbean Islands, north through the United States to Alaska and

northern Canada. This bat is known to feed over fields, lakes, and tree-lined streets. Big brown bats have been collected in cypress bays in the Okefenokee region (Harper, 1927). Howell (unpublished manuscript) reported specimens from Citrus County. The status of this bat in the project area is uncertain at present.

Southeastern Big-Eared Bat (State-Rare)

This bat is distributed over the middle and southeastern United States. Over most of its range it is associated with cave habitats. However, in Florida, preferred habitat is hammock-type vegetation within forested regions. Pearson (1954) reported the southeastern big-eared bat in Levy County and Howell (unpublished manuscript) and Neill (1953) recorded it in Marion County. The status of this bat in the area of the site is uncertain at this time.

Florida Weasel (State-Threatened)

The Florida weasel ranges throughout the southern two-thirds of peninsular Florida, excluding most of the southern tip. Apparently, the weasel lacks any distinct habitat preference (Moore, 1945 and 1949). There has been one recent sighting of this subspecies in a coastal hammock near Inglis, Florida. One of the state's rarest carnivores, the weasel may occur in the area of the proposed site.

Florida Mink (State-Rare)

The present range of the Florida mink is the northern third of the state in gulf coastal marshes. This subspecies may frequent the salt marshes adjacent to the proposed power plant. Since it is peripherally distributed in Florida and the preferred habitat is being encroached upon by man, it will continue to diminish in numbers.

Florida Manatee (Federal-Endangered)

A printout of Citrus County sightings was obtained from the 1974 to 1976 data bank. Table 2.7-17 presents a list of sightings reported near the existing power plant facility. The reported years cover a period of time when numerous researchers from the University of Florida were at

Table 2.7-17 Manatee Sightings Reported Near the Crystal River Site
to U.S. Fish and Wildlife for 1974-1976

Month	Year	Down*	Across	Number	Respondent
March	1975	482	592	1	B. Obry
March	1975	482	592	1	S. Rednour
March	1975	482	592	2	M. Osterling
June	1975	480	599	1	M. Homer
February	1975	479	595	1	M. Homer
March	1975	479	595	2	M. Homer
August	1975	479	596	1	C. Taylor
June	1975	478	595	1	P. Purcell

*The site of the present Crystal River facilities is about 480 down and 590 across in the Fish and Wildlife computer mapping system. For purposes of comparison, it may be useful to note that the coordinates of the Crystal River head springs are 496 down, 571 across.

Source: U.S. Fish and Wildlife Services, 1978.

work in the estuary surrounding the power plant site. It is safe to assume the area was observed more extensively than many other comparable areas during the same period and that scientifically trained observers were more likely to file reports of the sightings than were members of the general public. In short, the number of sightings of manatee in the vicinity of the facility is believed to be a result of more extensive observation and reporting for this particular study rather than an indication of any concentration of manatee in the area.

The data from the aerial survey have not yet been compiled. Mr. Powell of U.S. Fish and Wildlife who has been conducting these studies indicated that his initial impression before intensive study of the data indicated several trends. The manatee do not appear to be using the warm waters of the discharge in cold weather as extensively as has been observed at other sites. The nearby Crystal River spring waters have been reported to be a haven for the manatee (Hartman, 1971). It appears that the manatee are so strongly drawn to the ancestral meeting place at the Crystal River springs that they bypass the power plant discharge waters as a permanent residence. The researchers do feel that when the manatee are moving during fall and spring, they may use the discharge water as a temporary haven during sudden cold weather periods (Powell, 1978).

2.7.5 FUNCTIONALLY CRITICAL SPECIES

INTRODUCTION

Functionally critical species include those which are critical to the structure and function of the ecological system, and those which are important for the well-being of species in one of the preceding categories. These criteria include those species whose absence would destroy the integrity of a system, but not those dominants which could be replaced functionally by other currently existing species.

PLANTS

Live Oak, Cabbage Palm, Southern Red Cedar

These three species are the backbone (71 percent of the dominance) of the coastal hammock and coastal hydric hammock communities. These species are vital to the survival of these hammocks because of their relatively high resistance to oceanic salt spray and occasional salt water inundation (Wharton, et al., 1976). These species, especially live oak, tend to shelter other species which grow in the hammock and give it a high degree of floristic diversity. Because these species are more tolerant to salinity, they increase in dominance with increased proximity to the shore.

Live oak and red cedar have slow growth rates. Consequently, the large trees within the hammock are of a substantial age: 48 centimeters (19 inches) DBH live oak measured at 87 years old and 41 centimeters (16 inches) DBH red cedar measured at 114 years old. Replacement times for such a community would be substantially longer than the actual age of an individual tree because of the antecedent successional stages necessary for proper growth conditions.

Black Rush

This species is dominant in the salt marsh, where it accounts for at least 46 percent (Dames and Moore, 1974) of the vegetative cover. As such, it is responsible for much of the functional properties of the salt marsh system.

2.7.6 PREDICTED FUTURE ENVIRONMENT WITHOUT THE PROPOSED PLANT

There should be little to alter the present course of succession if the plant were not constructed. The transmission corridors are expected to be maintained in early successional stages by periodic mowing. Some additional disturbance probably will occur around the edges of the site through normal expansion of maintenance roads and other associated structures.

The site probably will be protected from fire over the foreseeable future by the wetlands on the west, and by fire prevention measures to protect the adjacent industrial complex and pine plantations. Regardless of the exclusion of fire, the marshes and hardwood forests are not expected to undergo major changes. The trees in the mesic and hydric hammocks should increase in size, but no change in species composition is expected, because the dominant climax species currently are seedlings.

The primary changes on the site would be due to succession in the pine flatwoods. Within 35 years of fire suppression, the flatwoods should be characterized by a pine canopy, with a substantial hardwood understory, and a more open shrub and ground cover layer (Edminston, 1963). A corresponding change in the associated animal community will occur as species more characteristic of the hardwood hammocks begin to replace those of early succession and pine flatwoods systems. The slash pines of the flatwoods are expected to approach harvestable size in about 15 to 25 years, depending on factors such as the amount of thinning which may occur. Harvesting would cause a return to an earlier successional state.

2.8

AMBIENT AIR

2.8.1 AMBIENT AIR STANDARDS

The ambient air quality of an area can be described in terms of quantitative standards. These standards, called Ambient Air Quality Standards (AAQS), were promulgated by regulatory agencies to protect the health and welfare of the general public. The applicable AAQS's which were established by the State of Florida are presented in Table 2.8-1. The major AAQS's to be evaluated for a fossil fuel field steam electric plant, located in a rural area, are those for total suspended particulate matter (TSP) and sulfur dioxide. Compliance with these standards is evaluated at ground level.

Existing levels of air quality must be determined in order to assess the impact of a proposed air pollution source, such as a major coal-fired electric generation plant. The most accurate method is to measure the air pollutants directly. Such procedures are accurate; however, they have limitations when determining existing ambient air quality over wide areas. In order to obtain spatial resolution of ambient air quality over such areas, many ambient monitors would be required.

The cost-effectiveness of such monitoring would not justify its use. When determining the existing environment on baseline, certain regulatory criteria allow the incorporation of air pollution sources which have started construction before the criteria were established.

To obtain the necessary spatial resolution while incorporating existing air pollution sources, atmospheric dispersion models are utilized. Such models are mathematical algorithms which simulate dispersion of air pollutants in the atmosphere.

The proposed new coal-fired units at Florida Power Corporation's Crystal River Plant necessitated both ambient air monitoring and atmospheric dispersion modeling for the determination of existing (baseline) ambient air quality. This section discusses the results of these analyses.

Table 2.8-1 State of Florida Air Quality Standards

Pollutant	Average Time	Frequency Parameter	Concentration	
			ug/m3	ppb
Sulfur Dioxide	3-hour	Annual maximum	1,300*	500
	24-hour	Annual maximum	260*	100
	1-year	Arithmetic mean	60	20
Suspended Particulate Matter	24-hour	Annual maximum	150*	---
	24-hour	Annual geometric mean	60	---

2.8.2 AMBIENT AIR SAMPLING PROGRAM

An ambient air sampling program for total suspended particulate matter (TSP) and sulfur dioxide was initiated in May, 1977, to determine baseline conditions in the vicinity of the proposed site. Four sampling stations were established near the proposed site, as shown in Figure 2.8-1. Sampling methods for this program are discussed in Chapter 6.

Presented in Table 2.8-2 are the observed TSP and sulfur dioxide non-continuous concentrations for the period May 7, 1977, through April 26, 1978. Continuous sulfur dioxide concentrations, which are presented in Table 2.8-3, were obtained from July 1, 1977, through January 25, 1978.

The TSP data obtained are indicative of the areas where monitoring was performed. Stations 1 and 2 are rurally located with minor sources of TSP in the general vicinity. These sources are primarily local dolomite mining and processing operations in addition to the existing Florida Power facility. Also, minor sources of fugitive dust are generated from unpaved roads in the area. Station 4, which recorded the lowest TSP concentrations, is located in a salt marsh near a small marina. This station, when impacted, is primarily influenced by one or two sources. The generally higher geometric standard deviation of this station is a statistical indicator of source receptor influence. The geometric standard deviation represents the slope of a log-normal distribution. Since TSP is generally log-normally distributed (Larsen, 1971; ESE, 1975), a higher slope indicates an infrequent source impact for rural areas, i.e., at lower frequencies of occurrence, concentrations are higher. Hence, Station 4 exhibits a source influence under certain meteorological conditions. The data obtained at Station 3 are representative of a typical small urban area like Crystal River. The station located adjacent to U.S. Highway 19/98 exhibited the highest concentrations, while the geometric standard deviation was the lowest (therefore many small sources contribute to the impact at this station). In summary, the observed TSP concentrations are within the ambient air

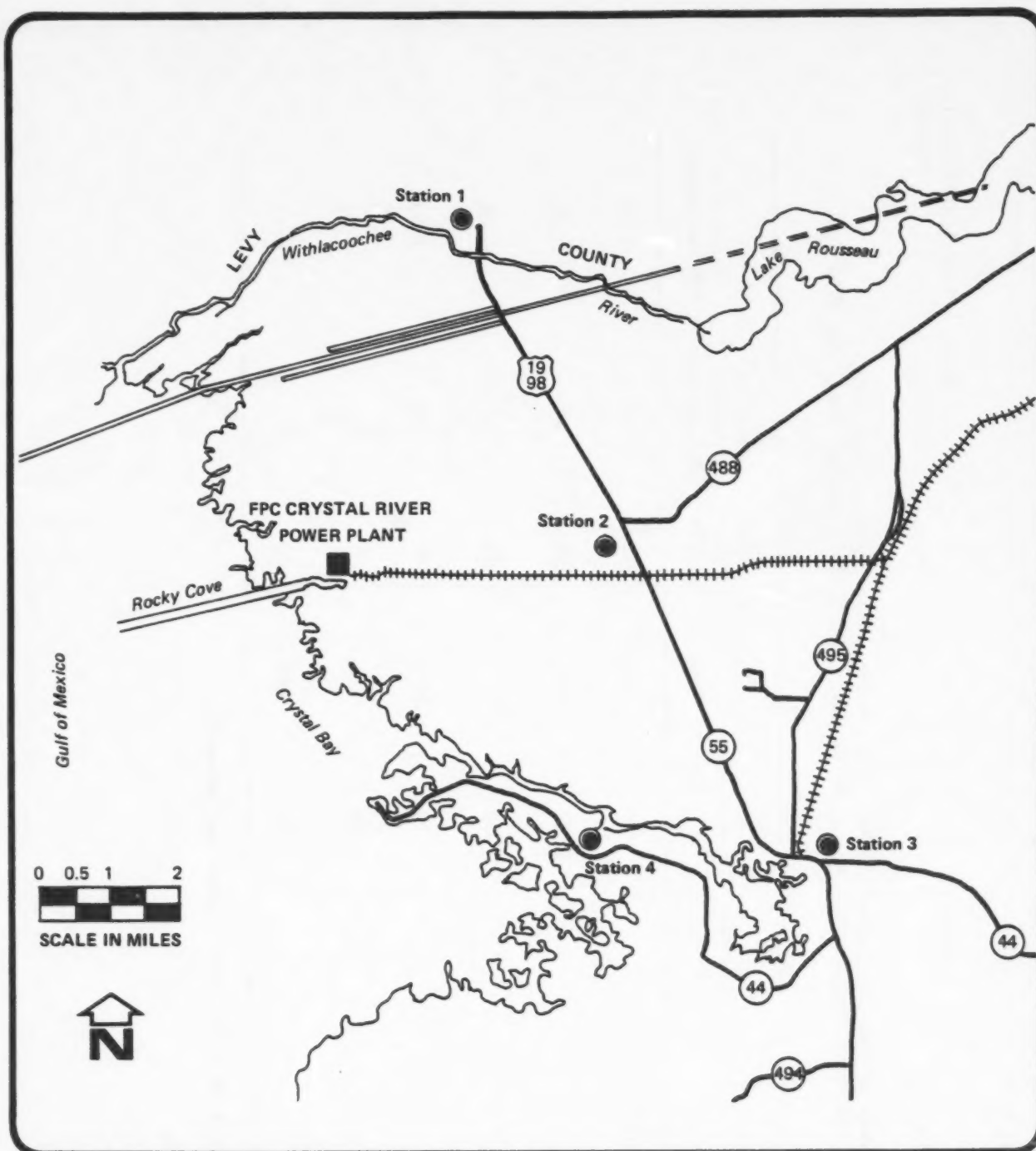


**Figure 2.8-1
AMBIENT AIR MONITORING LOCATIONS**

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Table 2.8-2 Summary of Non-Continuous* 24-Hour TSP and SO₂ Ambient Air Quality Data,
Florida Power Corporation Crystal River Site, May 7, 1977 through April 26, 1978

Pollutant	Station Number	Number of Samples	Mean	Observed 24-Hour Maximum	Observed 24-Hour 2nd Maximum	Geometric STD Deviation
Total Suspended Particulate	1	58	30 †	110	69	1.52
	2	52	25 †	80	67	1.71
	3	58	46 †	94	85	1.38
	4	50	30 †	78	63	1.53
Sulfur Dioxide	1	58	4**	16	8	1.51
	3	59	8**	47	31	2.12

* Monitor, operated on a once every sixth day schedule.

† Geometric mean.

** Arithmetic mean.

Table 2.8-3 Summary of the Continuous SO₂ Data, Florida Power Corporation, Crystal River, Florida,
July 1 through January 25, 1978. (Results in ug/m³)

Station Number	Percent Data Recovery (%)	Arithmetic Mean	Maximum 3-Hour Concentration	2nd Maximum 3-Hour Concentration	Maximum 24-Hour Concentration	2nd Maximum 24-Hour Concentration
2	86	15	416	375	105	103
4	93	8	192	165	58	58

quality standards. Any additional air pollution sources would have a considerable margin of compliance.

Sulfur dioxide, a gaseous air pollutant, was measured non-continuously; i.e., once every sixth day at Stations 1 and 3. These stations are located at the furthest point from the largest sulfur dioxide source in the area, Florida Power's Crystal River facility. Due to the source location and sampling frequency, all observed sulfur dioxide concentrations are below the minimum detectable limit of the method (25 ug/m^3) (CFR, 1976). The data from these stations should be considered as indicators of background sulfur dioxide concentrations.

The continuous monitors are located at distances and directions where maximum impact is expected to occur. In addition, the continuous monitors measure temporal resolution of air pollutant concentrations and allow greater sampling frequency than non-continuous monitors. Consequently, observed sulfur dioxide concentrations from Stations 2 and 4 were significantly greater than the non-continuous stations. Station 2 observed the highest sulfur dioxide concentrations. For the period of sampling (summer), mesoscale meteorological conditions include a large number of sea breezes, generally west-to-east winds. Such sea breezes created by convection are believed to produce maximum impact cases due to fumigation (Lyons, 1977). During the sampling period, northwesterly winds were infrequent. As a consequence, maximum sulfur dioxide concentrations were half as great as those at Station 2. Frontal systems which occur frequently in the fall and winter months will create impact cases at Station 2. These data will be supplemented with additional ambient observations. In summary, the sulfur dioxide data presented above indicate compliance with AAQS's.

2.8.3 DISPERSION MODELING

Modeling (refer to Chapter 6 for methods) for baseline air quality was performed in accordance with the definition of baseline air quality in the Clean Air Act Amendments of 1977 (PL95-95, August 7, 1977). According to the act, the existing air quality at the time of the first application for permit is considered the baseline. The baseline also includes additional sources not yet built, but for which construction commenced prior to January 6, 1975. For the purpose of determining the baseline air quality, existing Crystal River Units 1 and 2 were modeled as oil-fired using 2.35 percent sulfur fuel oil and 0.1 pounds TSP per million Btu heat input. The concentrations presented in this section are the maximum achievable baseline concentrations.

In Chapter 5, the maximum PSD increment is determined for the averaging times of one year, 24 hours, and 3 hours, respectively. In nearly all cases, the receptor at which this maximum increment was attained was not the same receptor which recorded the highest baseline concentration. This chapter, therefore, will be utilized to show only the maximum baseline concentrations. The maximum PSD increments will be shown in Chapter 5.

Recent promulgations by EPA and Congress have established ambient air quality levels for TSP and sulfur dioxide which cannot be exceeded (40CFR53, 1976; PL95-95, August 7, 1977). These limitations, which are termed Prevention of Significant Deterioration (PSD) increments, propose stricter limitations than do the AAQS's. (Refer to Chapter 8 for a more detailed discussion.) Associated with these PSD requirements are baseline concentrations above which only certain air quality is available. For the purposes of this discussion, baseline concentration as defined by the above legislation must be determined.

Baseline concentrations were determined at the plant site and at the Chassahowitzka National Wilderness Area. The latter has been designated as a Class I area by the 1977 Clean Air Act Amendments (PL95-95,

August 7, 1977). The respective Class I and Class II PSD increments are applicable to the impact of new units on the baseline environment.

Five years of meteorological data were available for model predictions from the U.S. Weather Bureau at Tampa International Airport. Maximum predictions were then performed utilizing the meteorology from worst days and 3-hour periods. Model estimates were made from the second-highest maximum concentrations since current regulations allow the short-term AAQS's and PSD increments to be exceeded once per year.

To estimate maximum annual and 24-hour TSP concentrations in the study area, a background concentration was incorporated with modeling results. This background was based on the ambient air quality modeling presented in Table 2.8-2.

2.8.4 BASELINE AIR QUALITY

The results of the baseline determination are presented in Table 2.8-4. Baseline concentrations were determined at the maximum in the study area, the Class II area where the proposed units are predicted to have maximum impact, and the Class I (Chassahowitzka Wilderness Area) areas where the proposed new units will have maximum impact.

Table 2.8-4. Maximum Estimated Baseline Concentrations ($\mu\text{g}/\text{m}^3$) in the Vicinity of Florida Power Corporation's Crystal River Site, and at the Chassahowitzka Wilderness Area (Units 1 and 2) on 2.7 Percent Sulfur Fuel Oil and at 0.1 lb TSP/ 10^6 Btu.

Pollutant	Average Time		
	Annual	24-Hour	3-Hour
<u>Sulfur Dioxide</u>			
Baseline Class II	5	65	374
Baseline Class I	1	30	100
AAQS	60	260	1,300
<u>Particulate Matter*</u>			
Baseline Class II	30	32	NA
Baseline Class I	30	31	NA
AAQS	60	150	

* Background TSP concentration of $30 \mu\text{g}/\text{m}^3$ applied to modeling results (geometric standard deviation of 1.4).

Note: An annual geometric mean of 60 corresponds to an arithmetic mean of $64 \mu\text{g}/\text{m}^3$ and a geometric standard deviation of 1.4.

All short-term AAQS cannot be exceeded more than once per year.

2.9

OTHER ENVIRONMENTAL FEATURES

2.9.1 NOISE

Sound is the perception of oscillations by the ear drum. These oscillations, or alternating regions of high and low pressure, are produced in the atmosphere by the vibration of an object.

Sound usually is described in terms of three wave variables: amplitude, frequency, and duration. Amplitude is a measure of the maximum excursion a sound wave makes from the average of the pressure or displacement of the wave. Frequency denotes the pitch of a pure tone and is the time required for the sound wave to oscillate between a positive and negative value of maximum amplitude. Duration is simply how long the sound persists.

The energy associated with a sound wave is described in terms of intensity. The intensity is proportional to the inverse square of the distance between the source and the receptor for spherically symmetrical waves. An energy flux is the average energy that flows through a unit area in unit time.

A system of measurement has been developed in which the average (rms) pressure excursions are measured against a reference pressure of 20 microneutons per square meter. A logarithmic scale has been designed with the sound pressure level (SPL) measured in decibels (dB) where:

$$SPL = 20 \log \frac{P}{.00002}$$

The pressure (P) is the root-mean-square sound pressure in microneutons per square meter.

The human ear perceives sound between the frequencies of 16 Hertz (cycles per second) and 20,000 Hertz (AIHA, 1975). However, the ear does not perceive sounds of equal pressure level throughout the range of perception as equally loud (see Figure 2.9-1). Sounds in the lower

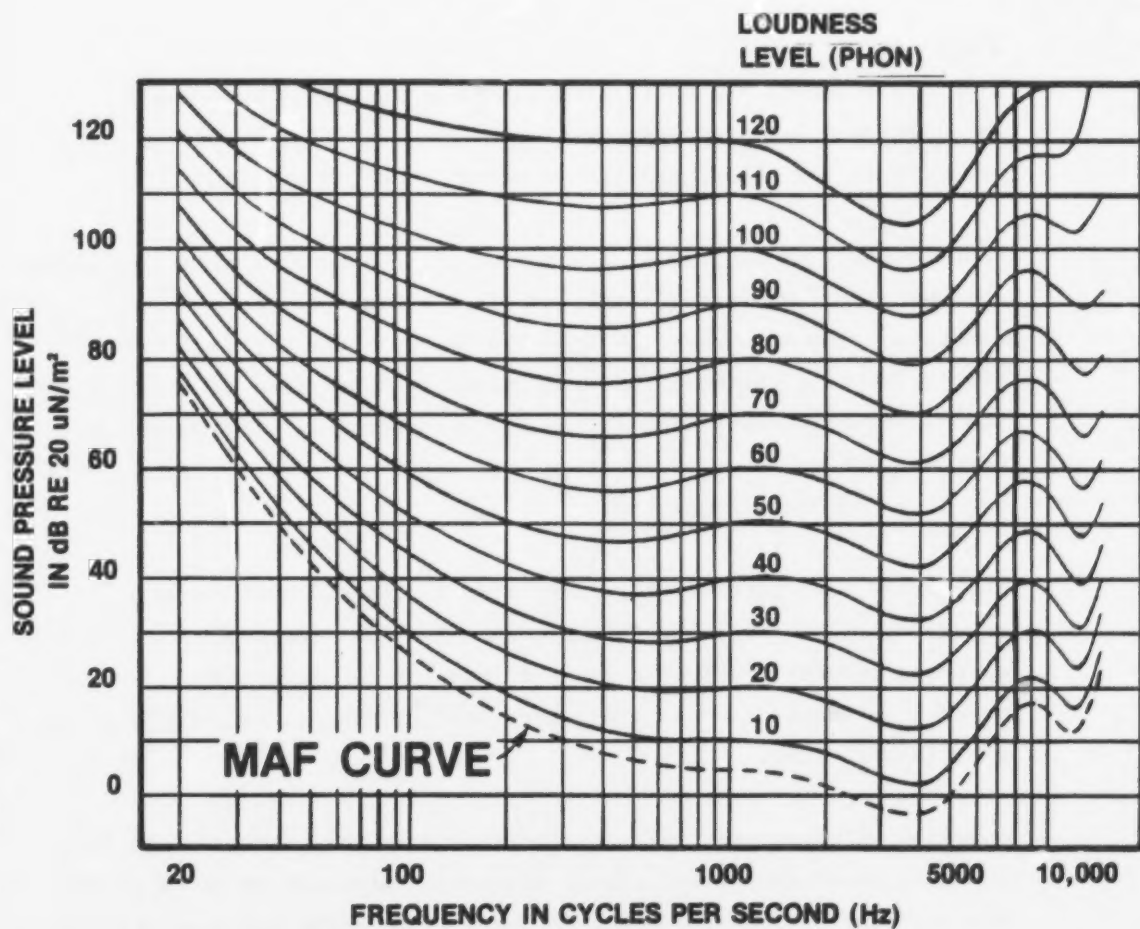


Figure 2.9-1
EQUAL LOUDNESS CONTOURS FOR PURE TONES

SOURCE: ROBINSON AND DADSON, 1956

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

and higher frequencies are not heard as easily as sounds in the mid-range.

Noise, which is defined as sound that is objectionable regardless of its level, is thus basically a subjective measurement. Noise can be excessive, erratic, intermittent, or statistically random.

A system of sound measurement based upon the response of the human ear has been developed. The quantity measured is the sound level (L) and the units are decibels (dB). The sound level follows a power law such that a 10 dB increase is perceived as a doubling of loudness. The addition of two equal but random noise sources results in a 3 dB increase in the total sound level. Figure 2.9-2 presents various sources and their sound levels on the A scale, which most nearly approximates the response of the human ear. Sound level decreases as a result of obstructions such as trees and natural buffer zones that attenuate the pressure waves. Sound levels may, however, be increased by obstructions that tend to reflect sound pressure.

Environmental noise can be measured with a sound level meter and expressed in terms of its frequency distribution, or by a scale which electronically attenuates certain frequencies to match the characteristics of the human ear (A-scale) or some other receptor. Most guidelines for environmental noise are defined in terms of the A-scale and are expressed as one of the following statistical measures (FHWA, 1973, and U.S. EPA, 1974):

1. L_{10} - the sound level which is exceeded 10 percent of the time during a measurement period.
2. L_{50} - the sound level which is exceeded 50 percent of the time during a measurement period.
3. $L_{eq}(t)$ - the sound level equal in cumulative energy to all time-varying noise produced during a specific time period.
4. $L_{eq}(24)$ - the sound level equal in cumulative energy to all time-varying noise produced during a 24-hour period.

AT A GIVEN DISTANCE
FROM NOISE SOURCE

DECIBELS
RE $20 \mu\text{N/m}^2$

ENVIRONMENTAL

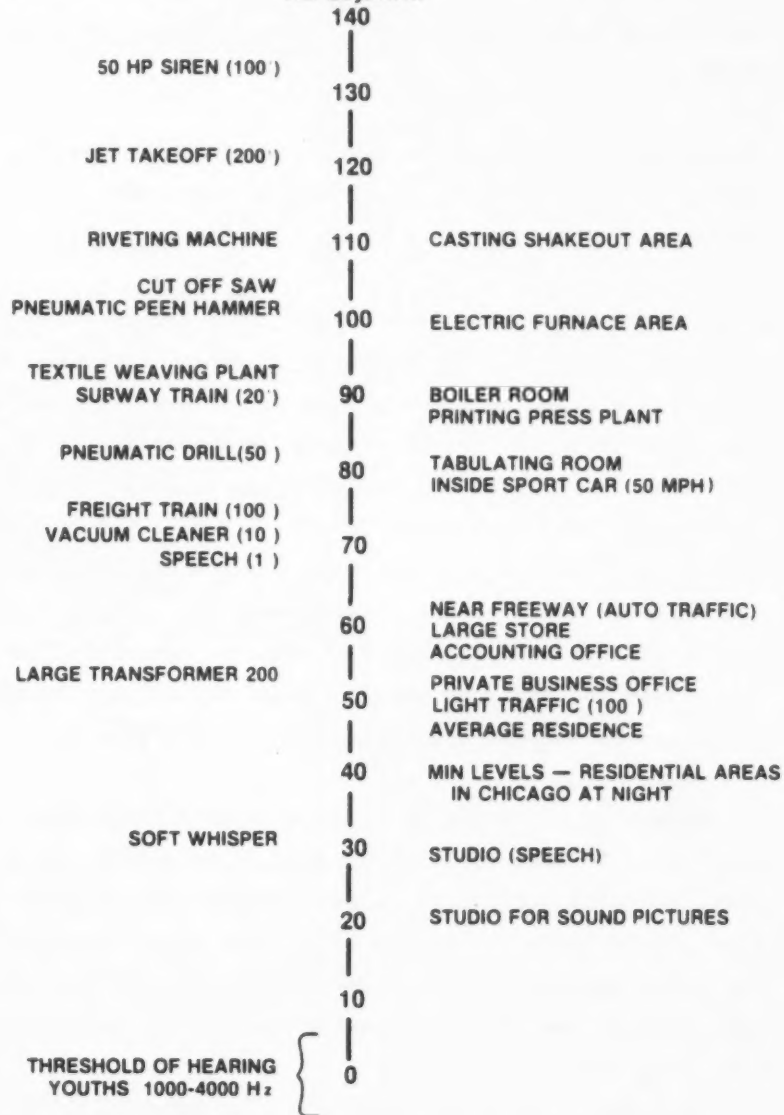


Figure 2.9-2
TYPICAL A-WEIGHTED SOUND LEVELS

SOURCE: PETERSON AND GROSS, 1974

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

5. $L_{eq}(dn)$ - the equivalent sound level for day and night (10:00 pm to 7:00 am) in which the equivalent nighttime level has been biased by the addition of ten decibels.

HEALTH AND WELFARE EFFECTS

Noise has been shown (U.S. EPA, 1974) to cause the following three types of effects on people and their activities:

1. Effects on hearing;
2. Effects on general mental state as evidenced by annoyance;
and
3. Interference with specific activities such as speech or sleep.

Noise is believed to cause stress and its related disorders. It was previously assumed that protection against hearing loss provided sufficient protection against stress-related disorders. It is now known that levels below those believed to affect hearing are sufficient to produce in human beings physiological symptoms that are related to stress (U.S. EPA, 1974).

GUIDELINES

Highway traffic has long been recognized as a major contributor to environmental noise. The U.S. Department of Transportation has published Design Noise Level criteria based upon land use (DOT, 1972). The suggested criteria are the L_{10} 's for various land-use categories and are reproduced in Table 2.9-1.

The U.S. EPA has published noise level limitations requisite to protect the public against hearing loss or activity interference for various land-use categories (U.S. EPA, 1974). Sound levels, which are given as $L_{eq}(24)$ and $L_{31}(dn)$, are yearly averages on an energy basis (see Table 2.9-2). These values are for long-term exposures and take into consideration the cumulative effects of noise. Noise level limitations chosen to protect the public against hearing loss have been set such that 96 percent of the population will not experience a hearing

Table 2.9-1 Federal Highway Administration Design Noise Level/Land Use Relationships

Land Use Category	Design Noise Level - L ₁₀ *	Description of Land Use Category
A 60 dBA		Tracts of lands in which serenity and quiet are of extraordinary (Exterior) significance and serve an important public need, and where the preservation of those qualities is essential if the area is to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, or open spaces which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	70 dBA (Exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, recreation areas, playgrounds, active sports areas, and parks.
C	75 dBA (Exterior)	Developed lands, properties, or activities not included in categories A and B above.
D	Variable	For requirements on undeveloped lands, see paragraphs 5a(5) and (6), Federal Highway Administration policy and procedure manual.
E	55 dBA	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

* L₁₀ represents the level which can be exceeded not more than 10 percent of the time.

Source: U.S. Federal Highway Administration, 1973.

Table 2.9-2 Yearly Average* Equivalent Sound Levels Identified as Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety

Land Use	Measure	Indoor			Outdoor		
		Activity Inter-ference	Hearing Loss Consideration	To Protect Against Both Effects (b)	Activity Inter-ference	Hearing Loss Consideration	To Protect Against Both Effects (b)
1 Residential with outdoor space and farm residences	L _{dn} 55 Leq (24)	45	70	45	55	70	70
2 Residential with no outside space	L _{dn} (24) Leq (24)	45	70	45			
3 Commercial	Leq (24)	(a)	70	70(c)	(a)	70	70(c)
4 Inside Transportation	Leq (24)	(a)	70	(a)			
5 Industrial	Leq (24)(d)	(a)	70	70(c)	(a)	70	70(c)
6 Hospitals	L _{dn} (24) Leq (24)	45	70	45	55	70	55
7 Educational	Leq (24) Leq (24)(d)	45	70	45	55	70	55
8 Recreational Areas	Leq (24)	(a)	70	70(c)	(a)	70	70(c)

Table 2.9-2 Yearly Average* Equivalent Sound Levels Identified as Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety (Continued, page 2 of 2)

Land Use	Measure	Indoor		Outdoor	
		Activity Interference	Hearing Loss Consideration	Activity Interference	Hearing Loss Consideration
9 Farm Land and General Unpopulated Land	Leq (24)	To Protect Against Both Effects (b)		To Protect Against Both Effects (b)	
		(a)		70	
				70(c)	

Code:

- a. Since different types of activities appear to be associated with different levels, identification of maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity.
- b. Based on lowest level.
- c. Based only on hearing loss.
- d. An Leq (8) of 75 dB may be identified in these situations as long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an Leq of 60 dB.

Note: Explanation of identified level for hearing loss: the exposure period which results in hearing loss at the identified level is a period of 40 years.

*Refers to energy rather than arithmetic averages.

Source: U.S. EPA, Office of Noise Abatement and Control, 1974.

threshold shift of more than 5 dBA at 4000 Hertz in 40 years of continual exposure.

NOISE AT THE SITE

The Florida Power property near Crystal River, Florida, contains two fossil-fired units and one nuclear power plant. Noise sources include fuel transportation, coal-handling and transfer facilities, coal crushers, furnace firing, turbines, generators, draft fans, transformers, and numerous other power plant-associated operations. There is a certain amount of construction at the site which is also a primary noise source. A noise-monitoring survey was conducted on October 18, 1977. The purpose of this survey was to determine the existing ambient noise levels in the vicinity of the Crystal River site in order to estimate the noise impacts of the proposed action.

The monitoring survey was conducted at eleven stations in the study area to obtain a representative measure of the existing sound levels and to evaluate the rate of sound level reduction with distance. The locations of the eleven monitoring stations are shown in Figure 2.9-3. The site locations and site descriptions are included in Table 2.9-3. All of the stations were located on property owned by Florida Power and were concentrated in the vicinity of the existing facilities.

Calculated values for L_{10} , L_{50} , and L_{eq} at each monitoring station are summarized in Table 2.9-4. Comparison of the values shown in Table 2.9-1 and the health and welfare levels in Table 2.9-2 indicate the following conclusions.

1. No noise measurements were made at any monitoring stations that exceeded the criteria for industrial land use.
2. If Station 4 (Figure 2.9-3) is considered to be five meters from the center of the plant, the "drop off" rate may be depicted as shown in Figure 2.9-4. The points do not lie on the straight line shown because there are several point sources at the center, and the buildings and vegetation cause varying

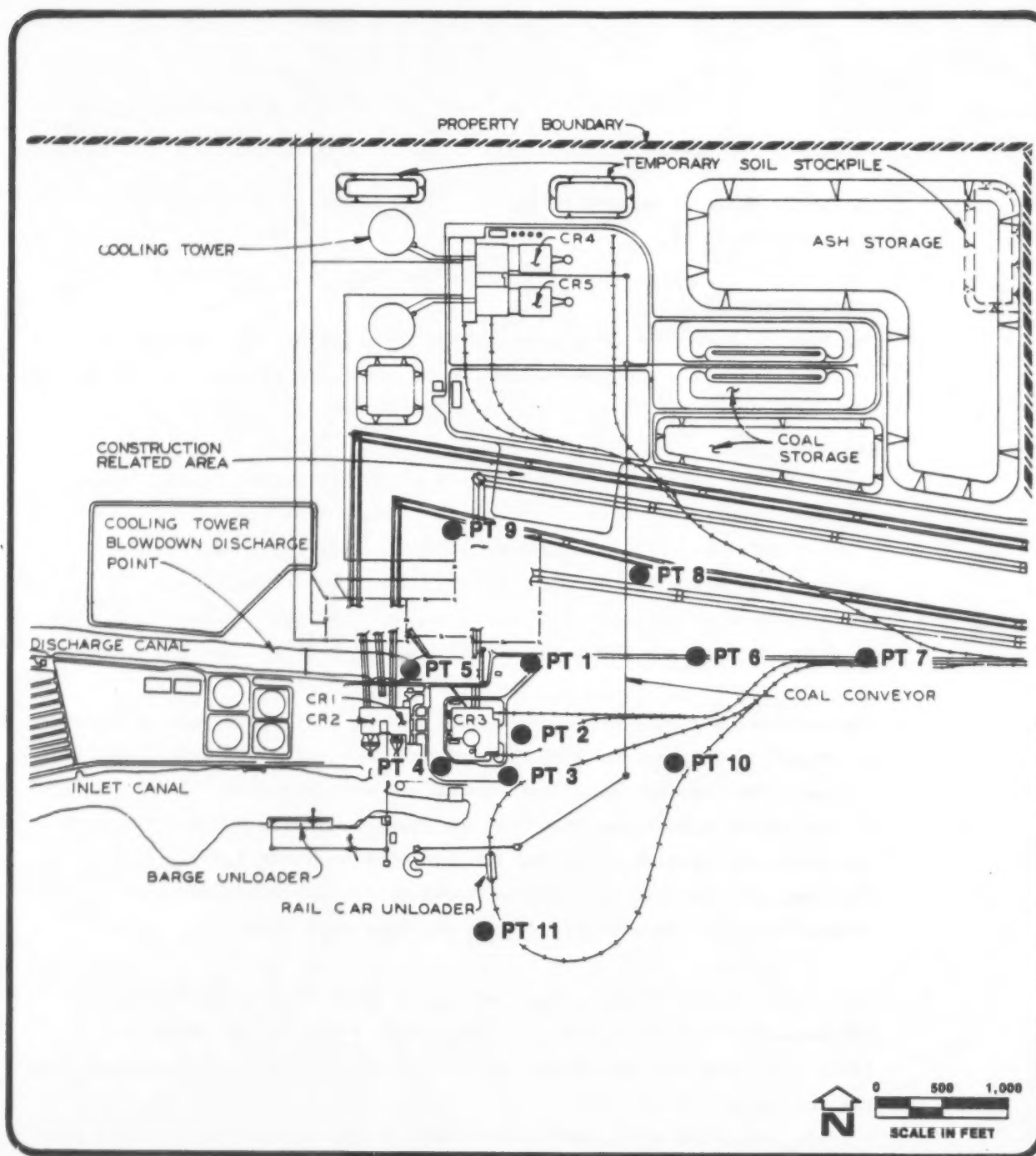


Figure 2.9-3
LOCATION OF NOISE MEASUREMENT SITES
AT THE EXISTING FLORIDA POWER CORPORATION
CRYSTAL RIVER PLANT, OCTOBER 18, 1977

SOURCE: BLACK AND VEATCH, 1969
 ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Table 2.9-3 Locations and Characteristics of Noise Monitoring Stations

Station No.	Location and Description	Noise Sources	Land Use
1	Northeast corner of existing Florida Power facility adjacent to access road and guard house. Fossil fuel plant is mostly shielded by the nuclear plant.	Nuclear facility. Traffic noise. Construction work.	5/C
2	East side of nuclear plant about 9 meters from building. Construction work is south of this station.	Humming noise from nuclear plant. Construction equipment major contributor.	5/C
3	Southeast corner of nuclear plant. Construction work in close vicinity.	Nuclear plant construction equipment.	5/C
4	Southwest corner of nuclear plant and across from fossil fuel-fired plant. Nuclear plant is about 15 meters away and fossil fuel-fired plant is about 54 meters away.	Major contributor is the fossil fuel plant. Humming from nuclear plant-also exhaust fan.	5/C
5	North perimeter of both plants across the water discharge canal.	Fossil fuel plant. Nuclear plant.	5/C
6	East of facility, 4/10 of a kilometer on main access road. Wooded area on south road border. North of road is mostly brush.	Construction work is main contributor to noise. Plant facility is secondary. Also traffic noise.	5/C

Table 2.9-3 Locations and Characteristics of Noise Monitoring Stations (continued, page 2 of 2)

Station No.	Location and Description	Noise Sources	Land Use
7	East of facility 0.8 kilometers on main access road. Wooded area on south road border. North of road is mostly brush.	Traffic.	5/C
8	Northeast of plant 0.4 kilometers. Much undergrowth in area.	Both nuclear and fossil fuel plants.	5/C
9	North of plant 0.4 kilometers. Light vegetation between here and plant but dense vegetation elsewhere.	Both nuclear and fossil fuel plants.	5/C
10	Southeast of plant 0.4 kilometers. Construction underway between here and facility.	Construction is the major contributor.	5/C
11	South of plant 0.4 kilometers. Construction is underway to the northeast from here.	Both nuclear and fossil fuel plants. Construction work.	5/C

Source: Environmental Science and Engineering, Inc., 1977.

Table 2.9-4 Noise Levels Measured at Florida Power Corporation
Site, Crystal River, October 18, 1977

Station Number	L ₁₀	L ₅₀	L _{eq}
1	59	57	58
2	61	59	59
3	63	61	61
4	67	67	67
5	61	59	59
6	41	41	41
7	37	33	33
8	45	45	45
9	49	47	47
10	59	57	58
11	61	59	59

Source: Environmental Science and Engineering, Inc., 1977.

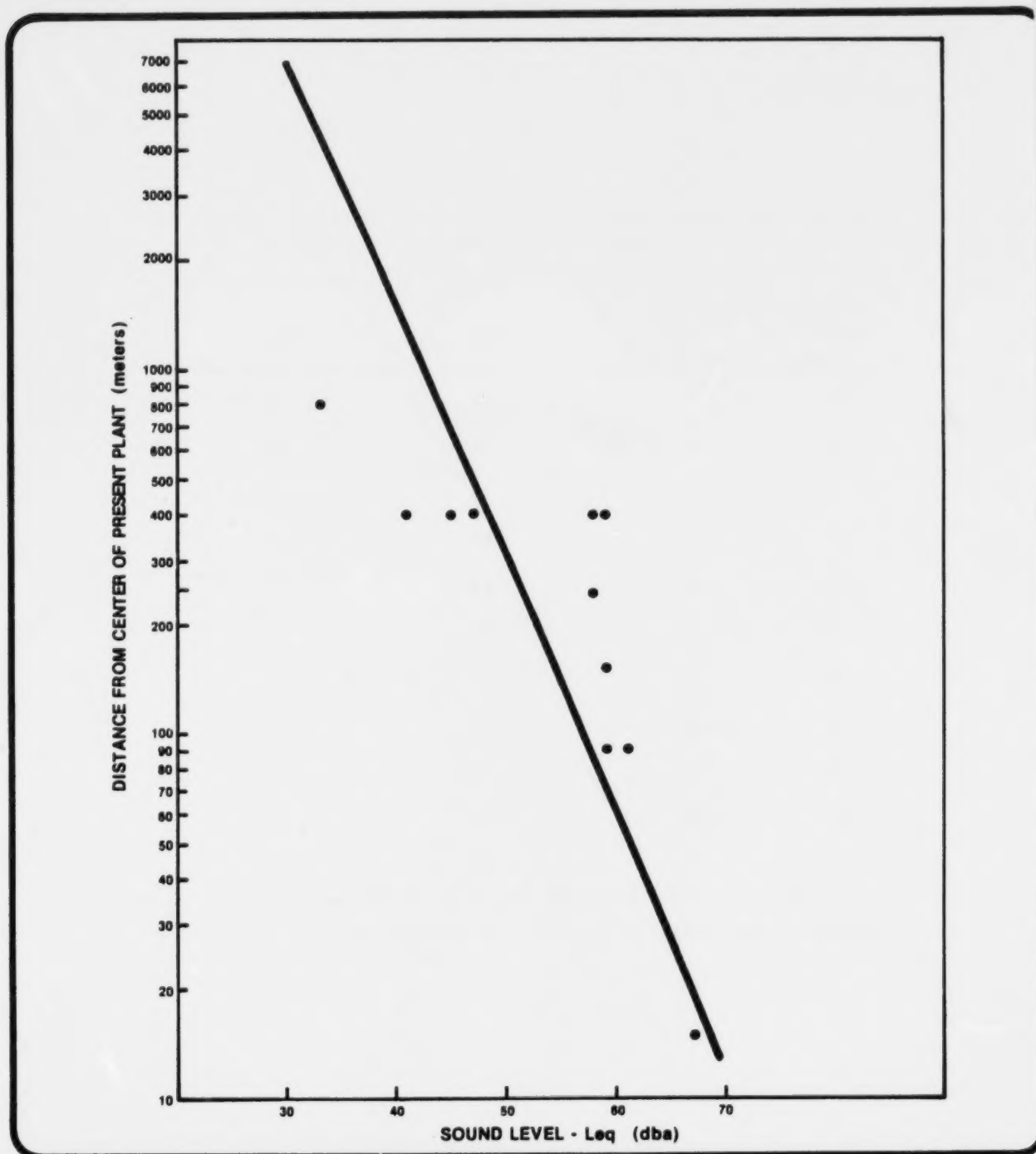


Figure 2.9-4
NOISE MEASUREMENTS (L_{eq}) AS A FUNCTION OF
DISTANCE FROM EXISTING FLORIDA POWER
CORPORATION CRYSTAL RIVER FACILITY,
OCTOBER 18, 1977

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1977

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

degrees of attenuation. The line shown is quite conservative away from present plant facilities. According to the data, point seven is virtually equal to noise floor measurements and is almost out of the sphere of influence of the plant. The residential areas to the south and southeast of the plant are remote and unaffected by the existing facility. The only effects which the existing facility has on these areas is traffic-induced noise.

2.9.2 NATURAL SEA SALT

Figures 2.9-5, 2.9-6, and 2.9-7 indicate the trends for salt concentration and deposition as a function of distance from the coastal boundary. The corrosion rate caused by natural sea drift falls off rapidly with increasing distance from the sea. Studies show that in coastal areas, the corrosion rates of iron, stainless steel, and aluminum decrease by factors of 10, 3, and 21, respectively, as the distance increases from about 25 meters (80 feet) to about 250 meters (800 feet) inland (Roffman, et al., 1973). High precipitation rates tend to wash off the salt and thus reduce the corrosion rate, but high humidity and fog keep the surface wet and enhance corrosion. Structures in warm areas, with long periods of exposure to sunshine, experience less corrosion due to the fast evaporation of the droplets.

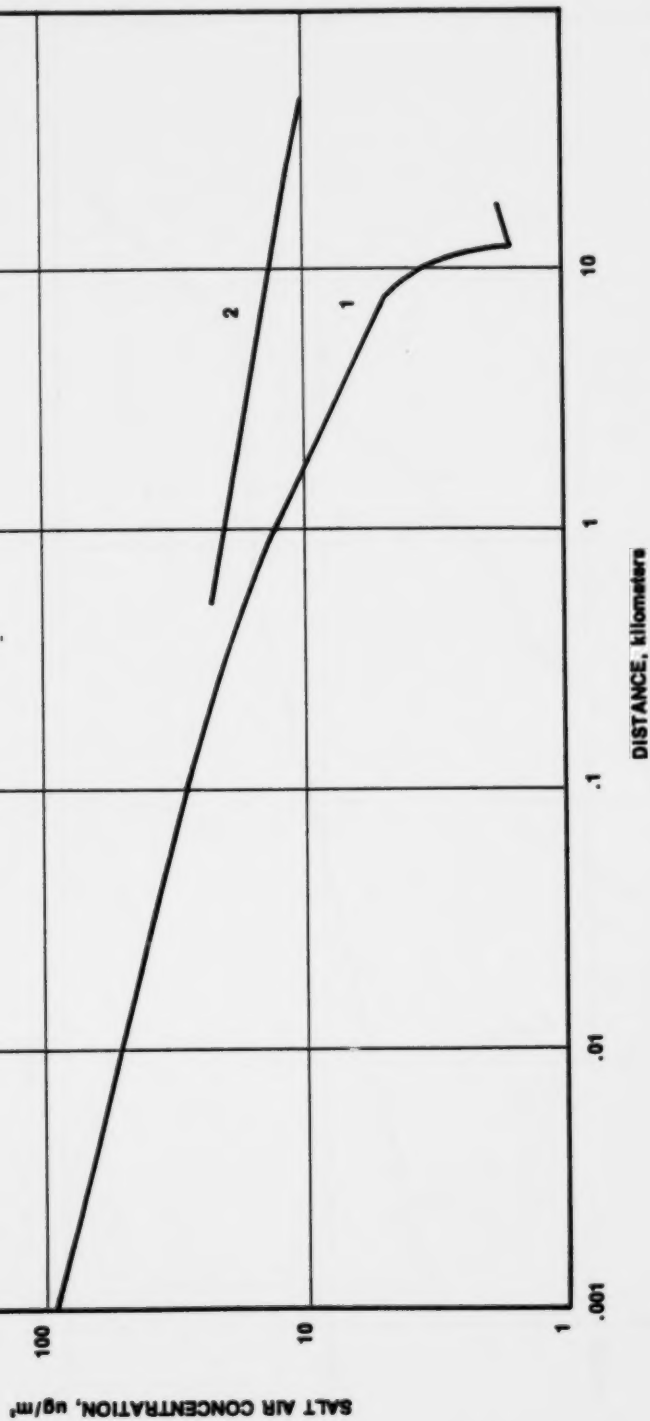


Figure 2.9-5
AIR CONCENTRATION OF SALT DRIFT AS A FUNCTION OF DISTANCE FROM THE SEA

SOURCE: WESTINGHOUSE ELECTRIC, 1973

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

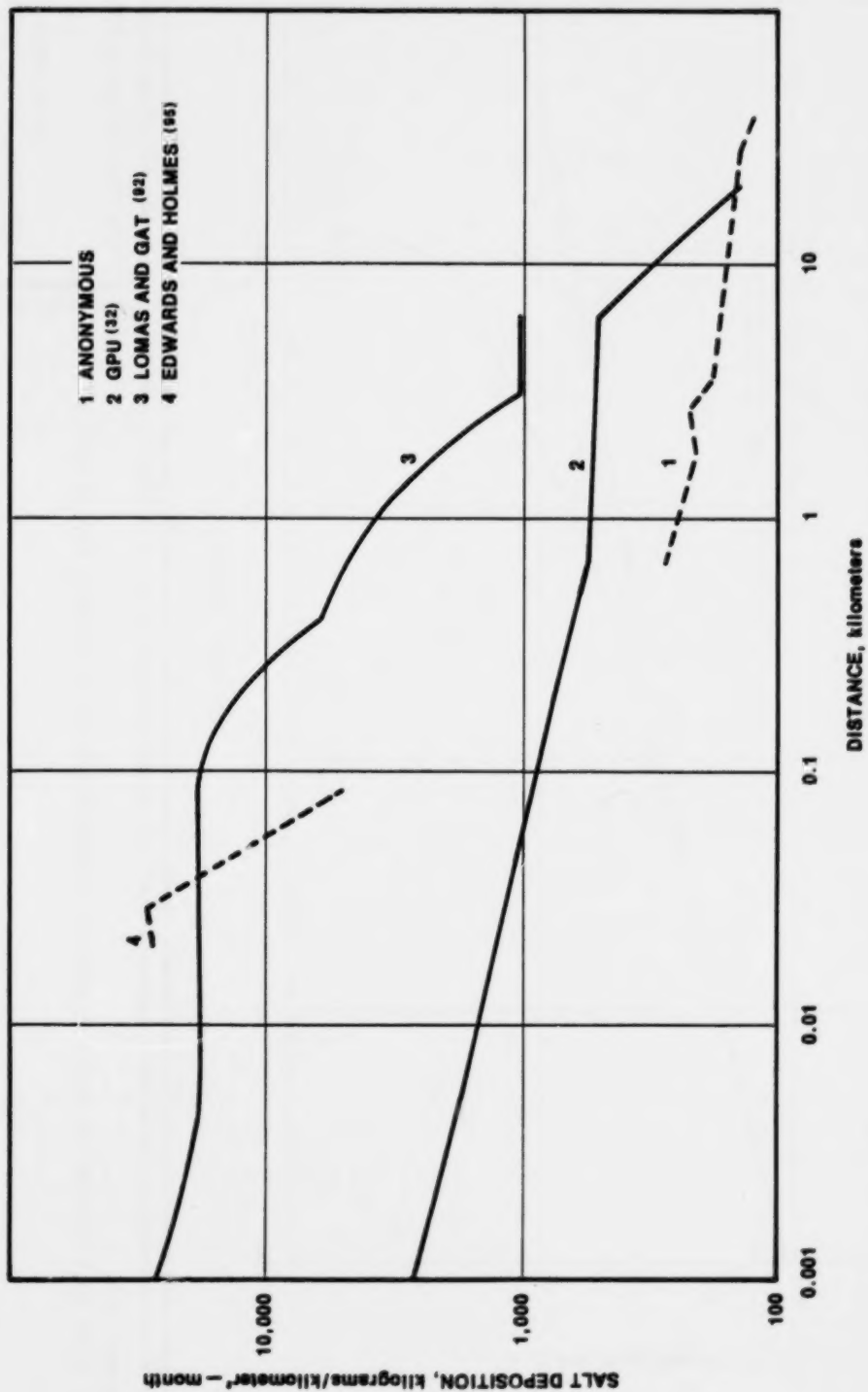


Figure 2.9-6
NATURAL DRIFT DEPOSITION RATE AS A FUNCTION OF DISTANCE FROM THE SEA

SOURCE: WESTINGHOUSE ELECTRIC, 1973

FLORIDA POWER CORPORATION

PROPOSED

CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

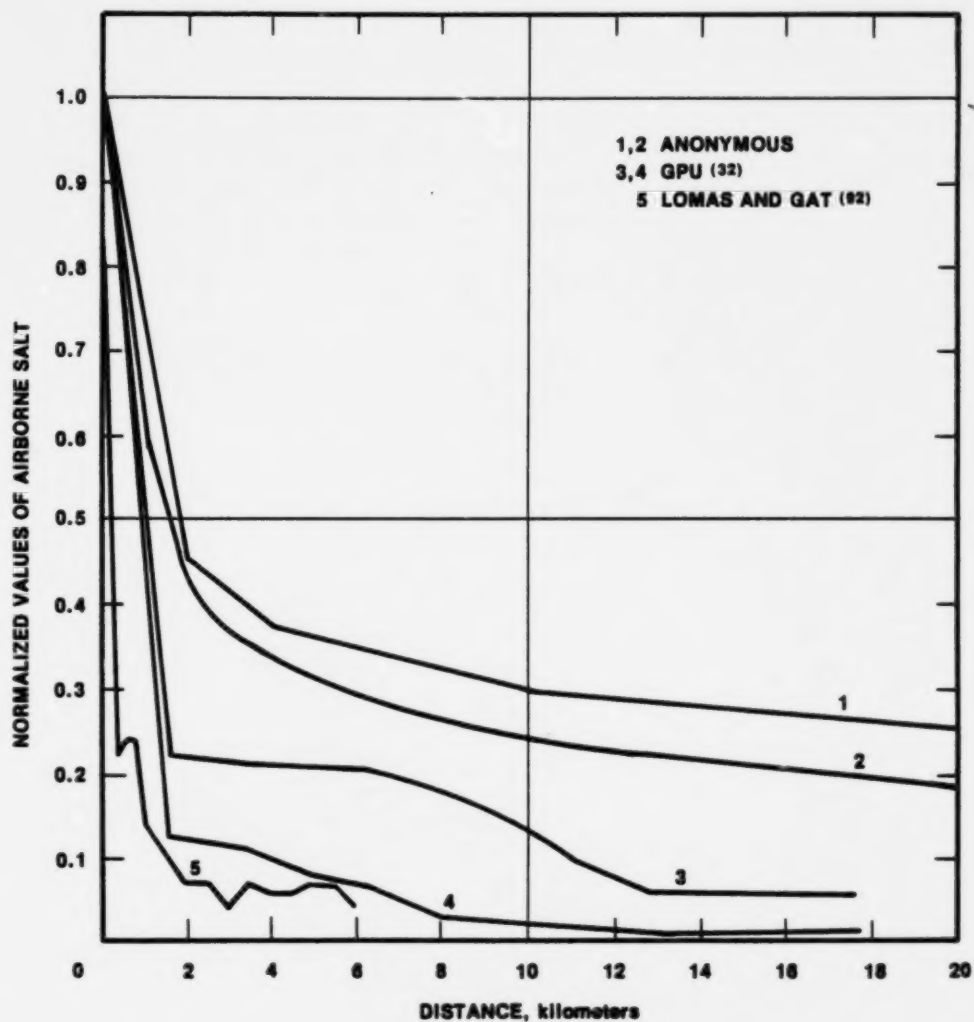


Figure 2.9-7
NORMALIZED AIRBORNE SALT VALUES AS A
FUNCTION OF THE DISTANCE INLAND
(WITH AN INITIAL VALUE OF ONE AT SEA SHORE)

SOURCE: WESTINGHOUSE ELECTRIC, 1973

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

CHAPTER 3
TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
3.0 <u>THE PLANT</u>	3-1
3.1 ARRANGEMENT AND EXTERNAL APPEARANCE	3-1
3.1.1 Site Arrangement	3-1
3.1.2 External Appearance	3-7
3.2 FUEL	3-9
3.2.1 Fuel Types and Quantities	3-9
3.2.2 Fuel Transportation	3-19
3.2.3 Coal Handling Facilities	3-19
3.2.4 Fuel Storage	3-23
3.3 PLANT WATER USE	3-25
3.3.1 Water Sources	3-31
3.3.2 Water Treatment	3-34
3.3.3 Station Consumption Uses	3-36
3.4 HEAT DISSIPATION SYSTEM	3-39
3.4.1 Cooling System Description	3-39
3.4.2 Cooling Water Description	3-43
3.5 CHEMICAL AND BIOCIDES WASTES	3-49
3.5.1 Circulating Water System	3-54
3.5.2 Steam Cycle Losses	3-55
3.5.3 Ash Transport Water	3-56
3.5.4 Metal Cleaning Wastes	3-57
3.5.5 Low-Volume Waste Sources	3-59
3.5.6 Material Storage Runoff	3-63
3.5.7 Transformer Oil Spill Prevention and Recovery	3-65
3.5.8 Fuel Oil Spill Prevention and Recovery	3-67
3.5.9 Waste Treatment and Disposal Systems	3-69
3.5.10 Plant Drains Collection Pond	3-71

CHAPTER 3

TABLE OF CONTENTS
(CONTINUED, PAGE 2 OF 2)

<u>Section</u>	<u>Page</u>
3.6 SANITARY AND OTHER WASTE SYSTEMS	3-72
3.6.1 Sanitary Waste System	3-72
3.6.2 Solid Waste Handling and Disposal	3-74
3.7 AIR EMISSIONS	3-81
3.7.1 Design Requirements	3-81
3.7.2 Control Systems Description	3-88
3.8 DIRECTLY ASSOCIATED TRANSMISSION	3-95
3.9 DIRECTLY ASSOCIATED FACILITIES	3-96
3.9.1 Arrangement	3-96
3.9.2 Adjacent Land Use	3-100
3.9.3 Visibility	3-101
3.10 ONSITE DRAINAGE AND EROSION CONTROL	3-102
3.10.1 Runoff Collection Ditch System	3-102
3.10.2 Construction Erosion and Runoff Control	3-108

CHAPTER 3

LIST OF TABLES

<u>Table</u>		<u>Page</u>
3.2-1	Alternative Coal Sources	3-10
3.2-2	Alternative Florida Power Corporation Performance Coals Weight Blends, 50/50 Basis	3-18
3.3-1	Crystal River Units 4 and 5 Site and Plant Water Use	3-27
3.3-2	Well Water Analyses	3-32
3.4-1	Monthly Inlet and Discharge Sea Water Temperature for Crystal River Units 1, 2 and 3	3-44
3.4-2	Temperature Range of Cooling Tower Blowdown for Crystal River Units 4 and 5	3-45
3.4-3	Gulf Coastal Salt Water Quality Data	3-46
3.4-4	Quality of Cooling Tower Blowdown for Crystal River Plant Units 4 and 5	3-47
3.4-5	U.S. Environmental Protection Agency Standards of Performance for New Sources: Maximum Allowable Dis- charge Concentrations by Waste Source	3-50
3.6-1	Crystal River Plant Solid Waste Quantities, Units 4 and 5	3-79
3.7-1	Combustion Products	3-82
3.7-2	Flue Gas Flow Rates and Emissions at Peak Load	3-85
3.7-3	Applicable Regulations for Coal and Ash Handling System	3-87
3.7-4	Suggested Design Parameters for Electrostatic Precipitator	3-90
3.7-5	Particulate Emissions from Coal and Ash Handling	3-93

CHAPTER 3
LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
3.1-1	Property Boundary	3-2
3.1-2	Crystal River Site Layout	3-3
3.1-3	Artist's Perspective Crystal River Site	3-4
3.1-4	Crystal River Facility Layout	3-5
3.1-5	Elevation Looking West	3-6
3.1-6	Unit 4 and 5 Plant Profile	3-8
3.2-1	Coal Handling Facilities	3-21
3.2-2	Coal Handling Facilities--Isometric	3-22
3.3-1	Plant Water Use Diagram	3-26
3.4-1	Cooling Tower Make-Up Intake Structure	3-40
3.4-2	Cooling Tower Make-Up Intake Structure	3-41
3.5-1	Plant Chemical Use Diagram	3-52
3.5-2	Transformer Oil Recovery	3-66
3.5-3	Fuel Oil Recovery	3-68
3.6-1	Bottom Ash and Pulverizer Rejects Handling	3-75
3.6-2	Ash Dewatering Bins	3-76
3.6-3	Fly Ash Handling	3-77
3.9-1	Roads and Railroads	3-97
3.9-2	Associated Facilities	3-98
3.10-1	Onsite Drainage System	3-103
3.10-2	Grading and Drainage	3-104

CHAPTER 3

LIST OF FIGURES
(Continued)

<u>Figure</u>		<u>Page</u>
3.10-3	Discharge Collection Structure	3-105
3.10-4	Discharge Canal--Discharge Structure	3-106

3.0 THE PLANT
3.1 ARRANGEMENT AND EXTERNAL APPEARANCE

3.1.1 SITE ARRANGEMENT

The site boundary and building layout for Units 4 and 5 at Crystal River are shown in Figures 3.1-1 and 3.1-2. The site includes approximately 1,540 hectares (3,810 acres) of land. Figure 3.1-3 is an artist's perspective of the plant site.

The installation of Units 4 and 5 has been designed to coordinate with existing Units 1, 2, and 3. The total cleared area for Units 1, 2, and 3 is approximately 129 hectares (319 acres). Existing facilities are used where practical to minimize impacts and costs. The plant layout is developed to facilitate plant operation and maintenance.

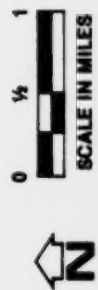
As shown in Figure 3.1-4, the central building complex for Units 4 and 5 will be located north of the central complex containing Units 1, 2, and 3. Approximately 135 hectares (333 acres) will be cleared for the construction of Units 4 and 5. The cooling towers for Units 4 and 5 will be located west of the units. The existing coal handling facilities will be expanded to accommodate the requirements for Units 4 and 5 with a coal storage east of the proposed units. The solid waste products will be stored in an area located east and southeast of Units 4 and 5.

Figure 3.1-5 shows the relationship of the site boundary to plant access roads and the transmission towers within the transmission corridor.

Reproduced from
best available copy.



Figure 3.1-1
PROPERTY BOUNDARY

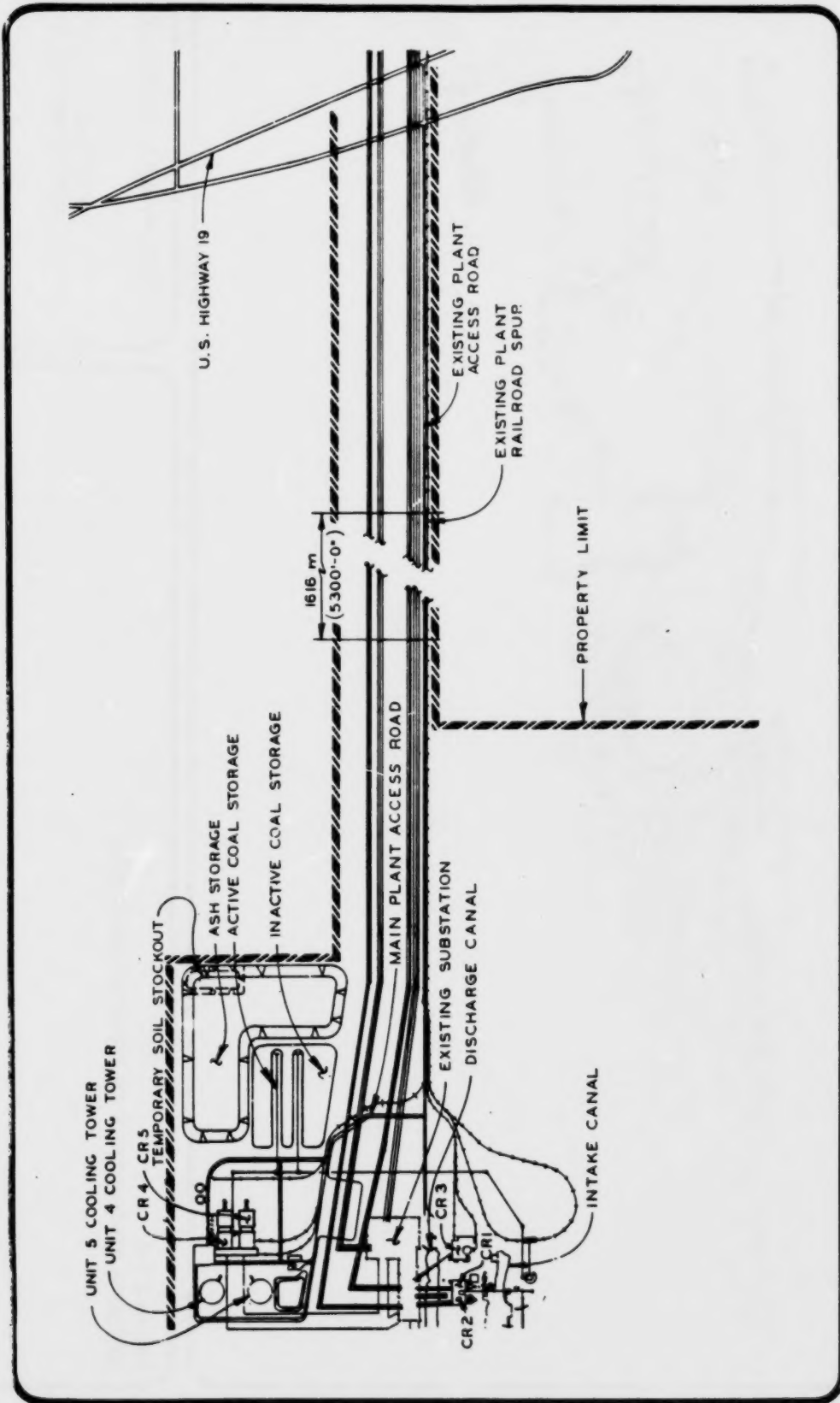


SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1976

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

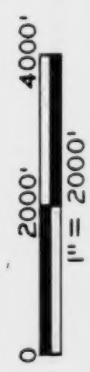


Figure 3.1-2
CRYSTAL RIVER SITE LAYOUT

SOURCE: BLACK AND VEATCH, 1980

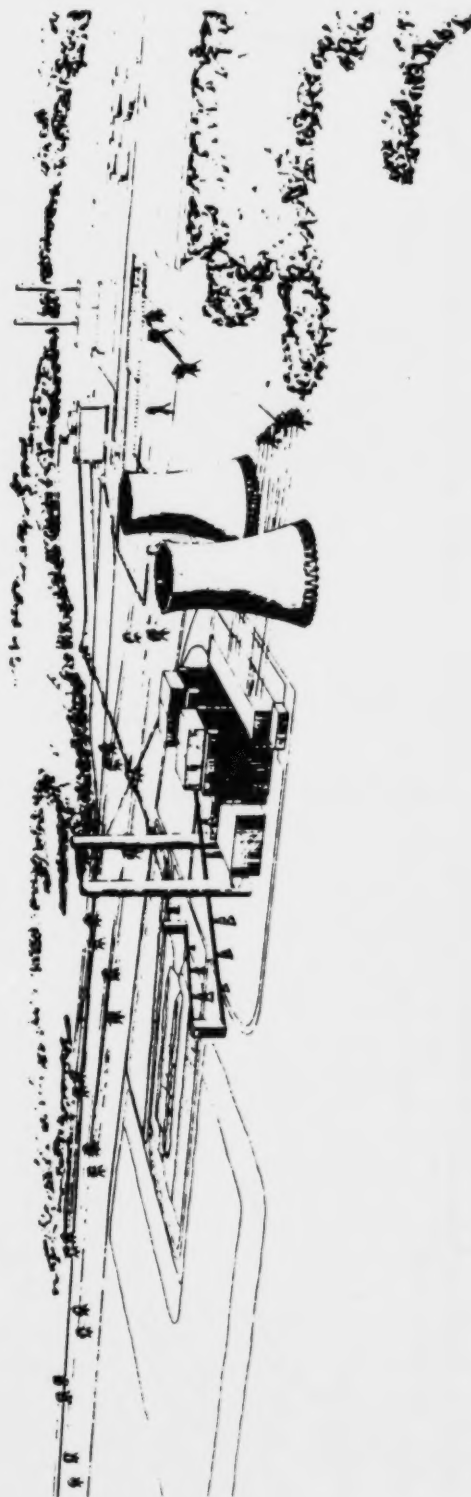


Figure 3.1-3
ARTIST'S PERSPECTIVE OF CRYSTAL RIVER SITE

SOURCE: BLACK AND VEATCH, 1976

FLORIDA POWER CORPORATION

**PROPOSED
CRYSTAL RIVER UNITS 4 & 5**

CITRUS COUNTY, FLORIDA

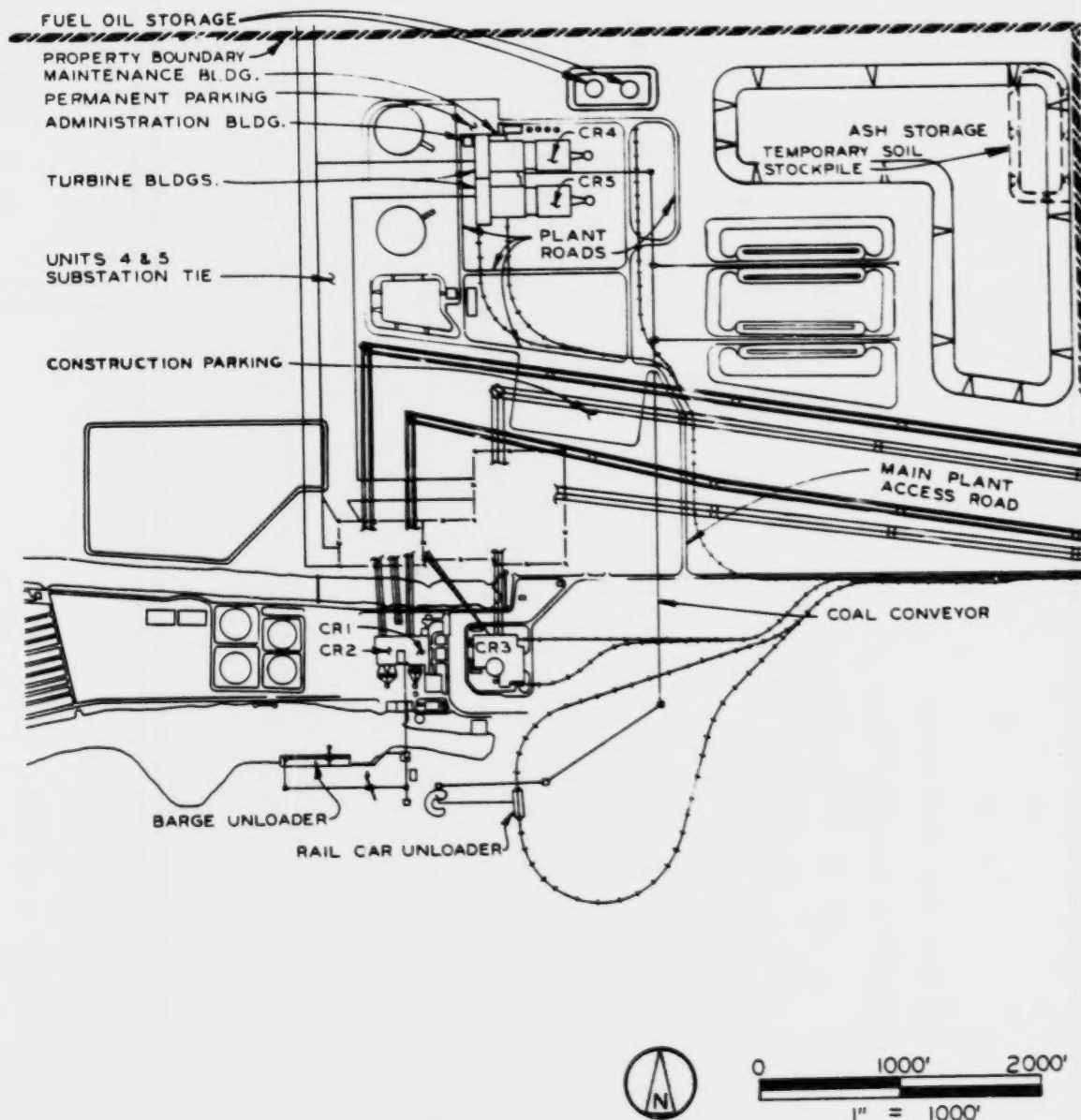


Figure 3.1-4
CRYSTAL RIVER FACILITY LAYOUT

SOURCE: BLACK AND VEATCH, 1980

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

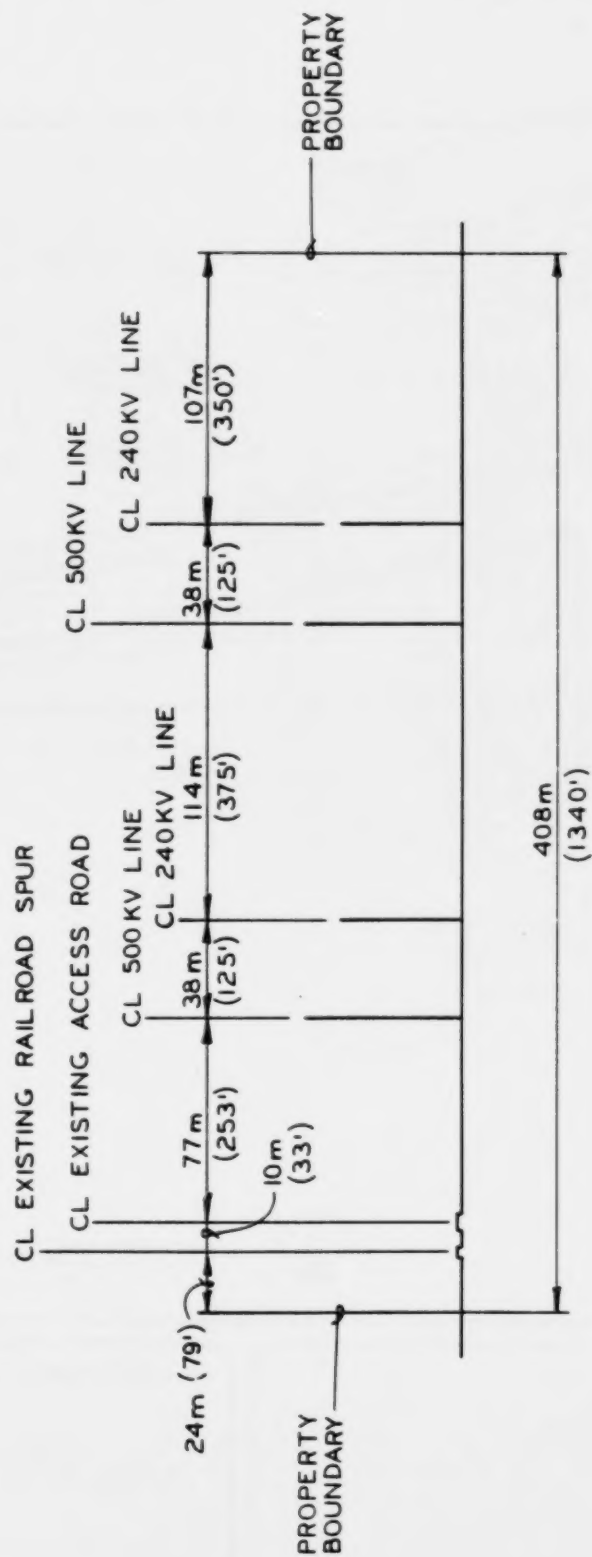
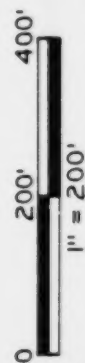


Figure 3. 1-5
ELEVATION LOOKING WEST
1829m (8000') EAST OF CONVEYOR CROSSING

SOURCE: BLACK AND VEATCH, 1980



FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

3.1.2 EXTERNAL APPEARANCE

The general external appearance of the plant has been developed in an attempt to achieve compatibility with existing facilities. New structures will be architecturally similar to Units 1 and 2 in design, color, and materials. The upper portions of enclosed main buildings will be enclosed with wall panels. Precast concrete wall panels will be used to enclose the lower or base portions. Smaller buildings in outlying areas utilize masonry, precast concrete, or wall panel enclosures compatible in appearance with the main buildings.

Grounds around the office building will be seeded and landscaped to prevent erosion and to complement the surrounding environment. Other areas will be seeded and landscaped as required to prevent erosion.

Figure 3.1-3 shows that there will be four chimneys on-site; the existing two for Units 1 and 2 and an additional two for Units 4 and 5. The chimneys on Units 1 and 2 are 152 meters (500 feet) tall and the chimneys on the proposed units will be approximately 183 meters (600 feet) tall. The steam generator housing for Units 1 and 2 is approximately 64 meters (210 feet) high and the housing for Units 4 and 5 will be approximately 81 meters (265 feet) high. Directly west of the steam generator structure is the long lower building which contains the turbine generators. The turbine generator building will be totally enclosed with wall panels on the upper portion and with masonry or wall panels on the base portions. The cooling towers will be natural draft, approximately 134 meters (440 feet) tall, and 113 meters (370 feet) in diameter at the base. The relative locations of the stacks and cooling towers are shown in profile in Figure 3.1-6. Other facilities such as a crusher building, coal piles, and containment for solid waste storage areas generally will be less than 31 meters (100 feet) high.

The 100-foot elevation shown on Figure 3.1-6 is the plant datum elevation. The Mean Low Water Level for the plant datum is 27 meters (88 feet).

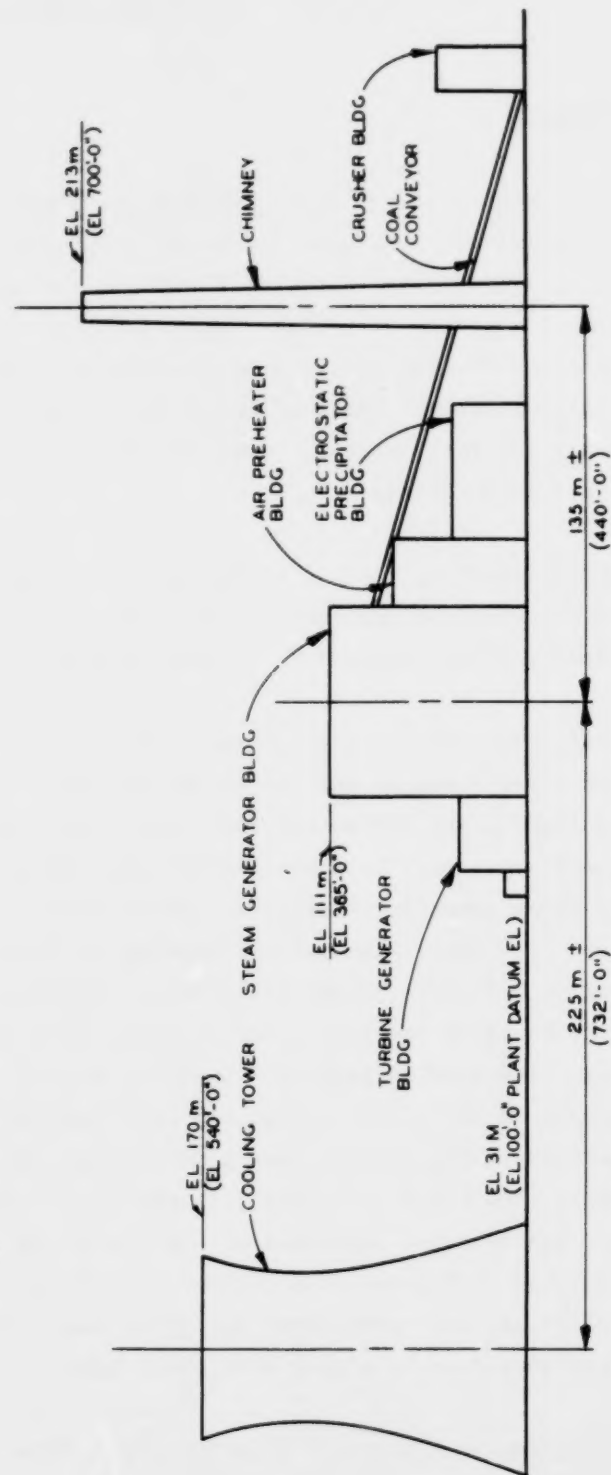


Figure 3.1-6
UNIT 4 & 5 PLANT PROFILE

SOURCE: Black and Veatch, 1980

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

3.2

FUEL

3.2.1 FUEL TYPES AND QUANTITIES

Coal supply contracts for the Crystal River Plant Units 4 and 5 are not yet complete. Plans are to utilize coal, or a blend of coals, which will meet the EPA sulfur emission standards without the use of flue gas scrubbers.

The coals which will provide compliance with the EPA standards are found in two geographical regions of the country, principally in the far western coal fields, and in the Appalachian coal fields. The Appalachian coals generally are a high quality, high Btu, high ash fusion, low sulfur coal. The western coals generally are of lower quality, and have lower Btu, higher ash, and higher moisture, but they are extremely low sulfur coals.

The proposed design coal for the Crystal River Units 4 and 5 is a 50/50 blend of a typical Appalachian and western coal. The various coals used to select the design blend are listed in Table 3.2-1. Fuel and ash analyses for the design blends are shown in Table 3.2-2. A 50/50 weight blend of Eastern Province and Campbell County, Wyoming coals (Nos. 1 and 7) were selected as the basis for the performance guarantee.

At the rated output (695 Mw gross), and the design blend coal heating value of approximately 23,923 kJ/kilograms (10,285 Btu per pound), the coal consumption will be approximately 294,000 kilograms (648,000 pounds) per hour for each unit. The average coal consumption per year over the 30-year life of Units 4 and 5 will be approximately 1,700,000 metric tons (1,870,000 tons) per year for each unit, based on a 0.66 annual average capacity factor.

Auxiliary fuel for furnace warm-up and coal ignition during start-up will be fuel oil. Diesel fuel and gasoline will be used to power the

Table 3.2-1 Alternative Coal Sources

	Typical	Range	
		Minimum	Maximum
Type (1)			
Eastern Province			
Ala., C. Ky., Tenn.,			
<u>Southern W. Va.</u>			
Moisture, %	7.0	4.0	12.0
Volatile matter, %	30.0	(28.0)	--
Fixed carbon, %	51.0	--	--
Ash, %	16.4	--	(16.0)
Carbon, %	77.0	--	--
Hydrogen, %	4.4	--	--
Nitrogen, %	1.4	--	--
Sulfur, %	0.50	--	0.8
Chlorine, %	0.05	--	(0.15)
Oxygen, % (by difference)	7.65	--	--
Gross calorific value, Btu/lb	12,450	11,000	13,000
Hardgrove Grindability Index	45	38	65
<u>Ash Fusibility, %</u>	<u>Red.</u>	<u>Oxid.</u>	<u>Reduction</u>
ID	2,250	2,350	--
ST	2,300	2,400	2,200
HT	2,330	2,440	--
FT	2,350	2,475	--
<u>Ash Analysis, %</u>			
P ₂ O ₅	0.40	--	--
SiO ₂	45.0	--	--
Fe ₂ O ₃	8.0	--	18.0
Al ₂ O ₃	24.0	--	--
TiO ₂	1.0	--	--
CaO	10.5	--	--
MgO	2.0	--	--
K ₂ O	1.50	--	--
Na ₂ O	0.50	--	0.80
SO ₃	6.0	--	--

Table 3.2-1 Alternative Coal Sources (Continued, page 2 of 8)

	Typical	Range	
		Minimum	Maximum
Type (2)			
<u>Utah</u>			
Moisture, %	7.0	4.0	12.0
Volatile matter, %	39.8	--	--
Fixed carbon, %	46.2	--	--
Ash, %	8.0	(5.0)	(16.0)
Carbon, %	69.2	--	--
Hydrogen, %	5.1	--	--
Nitrogen, %	1.4	--	--
Sulfur, %	0.7	(0.4)	(1.0)
Chlorine, %	0.05	(0.02)	(0.10)
Oxygen, % (by difference)	8.55	--	--
Gross calorific value, Btu/lb	12,000	10,500	12,500
Hardgrove Grindability Index	45	40	56
<u>Ash Fusibility, %</u>	<u>Red.</u>	<u>Oxid.</u>	<u>Reduction</u>
ID	2,130	2,210	--
ST	2,230	2,350	2,000
HT	2,250	2,390	--
FT	2,340	2,500	--
<u>Ash Analysis, %</u>			
P ₂ O ₅	0.5	--	--
SiO ₂	47.2	--	--
Fe ₂ O ₃	5.8	--	--
Al ₂ O ₃	22.4	--	--
TiO ₂	1.1	--	--
CaO	10.6	--	--
MgO	0.8	--	--
K ₂ O	0.4	--	--
Na ₂ O	4.5	2.0	6.0
SO ₃	6.2	--	--

Table 3.2-1 Alternative Coal Sources (Continued, page 3 of 8)

	Typical	Range	
		Minimum	Maximum
Type (3)			
<u>Colorado</u>			
Moisture, %	12.0	8.0	16.0
Volatile matter, %	35.4	--	--
Fixed carbon, %	46.6	--	--
Ash, %	6.0	(4.0)	(12.0)
Carbon, %	64.0	--	--
Hydrogen, %	4.0	--	--
Nitrogen, %	0.7	--	--
Sulfur, %	0.4	(0.3)	(0.8)
Chlorine, %	0.01	(0.01)	(0.06)
Oxygen, % (by difference)	12.29	--	--
Gross calorific value, Btu/lb	11,275	10,000	12,000
Hardgrove Grindability Index	49	44	55
<u>Ash Fusibility, %</u>	<u>Red.</u>	<u>Oxid.</u>	<u>Reduction</u>
ID	2,460	2,470	--
ST	2,465	2,500	2,200
HT	2,470	2,540	--
FT	2,520	2,600	--
<u>Ash Analysis, %</u>			
P ₂ O ₅	0.6	--	--
SiO ₂	37.5	--	--
Fe ₂ O ₃	4.7	--	--
Al ₂ O ₃	28.4	--	--
TiO ₂	1.3	--	--
CaO	9.6	--	--
MgO	3.3	--	--
K ₂ O	0.6	--	--
Na ₂ O	2.5	0.4	3.0
SO ₃	10.7	--	--

Table 3.2-1 Alternative Coal Sources (Continued, page 4 of 8)

	Typical	Range	
		Minimum	Maximum
Type (4)			
<u>Wyoming</u>			
Moisture, %	21.5	18.0	24.0
Volatile matter, %	32.5	--	--
Fixed carbon, %	40.0	--	--
Ash, %	6.0	(3.0)	(12.0)
Carbon, %	55.5	--	--
Hydrogen, %	3.9	--	--
Nitrogen, %	0.8	--	--
Sulfur, %	0.5	(0.3)	(1.0)
Chlorine, %	0.05	(0.01)	(0.05)
Oxygen, % (by difference)	11.75	--	--
Gross calorific value, Btu/lb	9,650	9,200	11,000
Hardgrove Grindability Index	50	44	55
<u>Ash Fusibility, %</u>	<u>Red.</u>	<u>Oxid.</u>	<u>Reduction</u>
ID	2,100	2,130	--
ST	2,280	2,310	2,120
HT	2,440	2,480	--
FT	2,600	2,650	--
<u>Ash Analysis, %</u>			
P ₂ O ₅	0.6	--	--
SiO ₂	49.8	--	--
Fe ₂ O ₃	6.9	--	--
Al ₂ O ₃	16.8	--	--
TiO ₂	0.5	--	--
CaO	8.3	--	--
MgO	4.6	--	--
K ₂ O	0.5	--	--
Na ₂ O	0.2	0.1	1.0
SO ₃	10.3	--	--

Table 3.2-1 Alternative Coal Sources (Continued, page 5 of 8)

	Typical	Range	
		Minimum	Maximum
<u>Type (5)</u>			
<u>Carbon Co., Wyoming</u>			
Moisture, %	12.0	9.0	15.0
Volatile matter, %	37.0	--	--
Fixed carbon, %	41.0	--	--
Ash, %	10.0	(7.0)	(15.0)
Carbon, %	60.0	--	--
Hydrogen, %	4.1	--	--
Nitrogen, %	0.9	--	--
Sulfur, %	0.6	(0.3)	(1.0)
Chlorine, %	0.03	(0.01)	(0.05)
Oxygen, % (by difference)	12.37	--	--
Gross calorific value, Btu/lb	10,000	9,500	10,500
Hardgrove Grindability Index	47	42	52
<u>Ash Fusibility, %</u>	<u>Red.</u>	<u>Oxid.</u>	<u>Reduction</u>
ID	2,070	2,100	--
ST	2,155	2,320	2,800
HT	2,200	2,340	--
FT	2,245	2,420	--
<u>Ash Analysis, %</u>			
P ₂ O ₅	0.8	--	--
SiO ₂	38.0	--	--
Fe ₂ O ₃	9.5	--	--
Al ₂ O ₃	23.9	--	--
TiO ₂	0.9	--	--
CaO	13.2	--	--
MgO	3.5	--	--
K ₂ O	1.3	--	--
Na ₂ O	0.4	0.3	3.0
SO ₃	9.0	--	--

Table 3.2-1 Alternative Coal Sources (Continued, page 6 of 8)

	Typical	Range	
		Minimum	Maximum
Type (6)			
<u>New Mexico</u>			
Moisture, %	15.0	12.0	21.0
Volatile matter, %	35.4	--	--
Fixed carbon, %	38.8	--	--
Ash, %	10.8	(10.0)	(20.0)
Carbon, %	55.7	--	--
Hydrogen, %	4.1	--	--
Nitrogen, %	1.0	--	--
Sulfur, %	0.6	(0.5)	(1.2)
Chlorine, %	0.02	(0.02)	(0.06)
Oxygen, % (by difference)	12.78	--	--
Gross calorific value, Btu/lb	9,700	8,750	10,000
Hardgrove Grindability Index	45	40	48
<u>Ash Fusibility, %</u>	<u>Red.</u>	<u>Oxid.</u>	<u>Reduction</u>
ID	2,280	2,399	-- --
ST	2,400	2,510	2,250 2,700+
HT	2,440	2,535	-- --
FT	2,520	2,620	-- --
<u>Ash Analysis, %</u>			
P ₂ O ₅	0.1	--	--
SiO ₂	53.6	--	--
Fe ₂ O ₃	5.4	--	--
Al ₂ O ₃	22.7	--	--
TiO ₂	1.0	--	--
CaO	4.3	--	--
MgO	1.5	--	--
K ₂ O	1.1	--	--
Na ₂ O	2.0	0.2	3.0
SO ₃	6.3	--	--

Table 3.2-1 Alternative Coal Sources (Continued, page 7 of 8)

	Typical	Range		
		Minimum	Maximum	
Type (7)				
Campbell Co., Wyoming				
Moisture, %	30.0	27.0	32.0	
Volatile matter, %	12.1	--	--	
Fixed carbon, %	32.1	--	--	
Ash, %	5.8	(6.5)	(11.0)	
Carbon, %	48.50	--	--	
Hydrogen, %	3.40	--	--	
Nitrogen, %	0.70	--	--	
Sulfur, %	0.48	--	--	
Chlorine, %	0.02	(0.01)	(0.06)	
Oxygen, % (by difference)	11.10	--	--	
Gross calorific value, Btu/lb	8,125	7,700	8,600	
Hardgrove Grindability Index	52	50	60	
Ash Fusibility, %	Red.	Oxid.	Reduction	
ID	2,060	2,070	--	--
ST	2,120	2,160	2,000	2,300
HT	2,140	2,180	--	--
FT	2,180	2,220	--	--
Ash Analysis, %				
P ₂ O ₅	2.0	--	--	
SiO ₂	34.0	--	--	
Fe ₂ O ₃	6.0	--	--	
Al ₂ O ₃	13.0	--	--	
TiO ₂	1.0	--	--	
CaO	20.0	--	--	
MgO	6.0	--	--	
K ₂ O	0.8	--	--	
Na ₂ O	2.8	1.0	4.0	
SO ₃	13.7	--	--	

Table 3.2-1 Alternative Coal Sources (Continued, page 8 of 8)

	Typical	Range	
		Minimum	Maximum
Type (8)			
<u>Illinois--Deep Mined</u>			
Moisture, %	10.00	7.0	10.0
Volatile matter, %	32.00	--	--
Fixed carbon, %	45.00	--	--
Ash, %	13.00	(7.0)	(16.0)
Carbon, %	62.00	--	--
Hydrogen, %	4.40	--	--
Nitrogen, %	1.20	--	--
Sulfur, %	4.20	(2.0)	(5.0)
Chlorine, %	0.18	(0.10)	(0.30)
Oxygen, % (by difference)	5.02	--	--
Gross calorific value, Btu/lb	11,000	10,500	12,500
Hardgrove Grindability Index	55	50	60
<u>Ash Fusibility, %</u>	<u>Red.</u>	<u>Oxid.</u>	<u>Reduction</u>
ID	1,950	2,320	--
ST	2,010	2,380	2,000
HT	2,030	2,435	--
FT	2,150	2,510	--
<u>Ash Analysis, %</u>			
P ₂ O ₅	0.20	--	--
SiO ₂	37.40	--	--
Fe ₂ O ₃	26.60	15.0	--
Al ₂ O ₃	16.00	--	--
TiO ₂	1.00	--	--
CaO	8.10	--	--
MgO	1.00	--	--
K ₂ O	1.65	--	--
Na ₂ O	1.20	0.50	1.
SO ₃	6.70	--	--

Source: Black and Veatch, 1978.

Table 3.2-2 Alternative Florida Power Corporation Performance Coals Weight Blends, 50/50 Basis

Type Coal	1 & 2	1 & 6	1 & 7*	2 & 4	2 & 6	2 & 7	6 & 7
Moisture, %	7.0	11.0	18.5	14.5	11.0	18.5	22.5
Volatile Matter, %	34.9	32.7	31.0	36.1	37.6	36.0	33.7
Fixed Carbon, %	49.1	45.9	42.6	42.4	42.0	38.6	35.5
Ash, %	9.0	10.4	7.9	7.0	9.4	6.9	8.3
Carbon, %	69.1	62.3	58.8	62.3	62.4	58.8	52.1
Hydrogen, %	4.7	4.3	3.9	4.5	4.6	4.2	3.7
Nitrogen, %	1.4	1.2	1.1	1.1	1.2	1.1	0.9
Chlorine, %	0.05	0.03	0.03	0.05	0.03	0.03	0.02
Sulfur, %	0.60	0.55	0.49	0.60	0.65	0.59	0.54
Oxygen, %	8.15	10.22	9.28	9.95	10.72	9.88	11.94
Gross Calorific Value, Btu/lb	12,225	11,075	10,285	10,825	10,850	10,060	8,910
Hardgrove Grindability Index	45	45	48	47	45	48	48
<u>Ash Analysis, %</u>							
SiO ₂	46.0	49.0	40.2	48.4	50.9	40.7	44.3
Al ₂ O ₃	23.3	23.3	18.2	19.8	22.5	17.8	18.1
TiO ₂	1.0	1.0	1.0	0.8	1.0	1.1	1.0
Fe ₂ O ₃	7.0	6.6	7.1	6.3	5.6	5.9	5.7
CaO	10.5	7.1	15.3	9.5	6.8	15.2	11.8
MgO	1.5	1.7	3.7	2.6	1.2	3.4	2.6
Na ₂ O	2.28	1.31	1.50	2.48	3.01	3.67	2.38
K ₂ O	1.01	1.28	1.20	0.43	0.82	0.60	0.96
SO ₃	6.1	6.2	9.3	8.1	6.3	9.9	9.8
P ₂ O ₅	0.44	0.24	1.1	0.55	0.28	1.24	1.00

*Performance guarantee shall be based on this blend.

Source: Black and Veatch, 1978.

emergency fire pumps and mobile coal and ash handling equipment. Average fuel oil consumption will be approximately 10,600 cubic meters (2,800,000 gallons) per year for each unit, based on 200 starts per year.

3.2.2 FUEL TRANSPORTATION

In order to maintain a diversity of supply, approximately 50 percent of the coal will be transported to the Crystal River site by unit trains and 50 percent will be transported to the site in oceangoing barges.

The Appalachian coal will be transported in 70- to 110-car unit trains of approximately 90.7-metric ton (100-ton) capacity cars. An average of 4 to 6 trains per week will be required to supply 50 percent of the coal, assuming the present projections for plant capacity factors.

The western coals will be transported from the coal fields to the Mississippi River by unit rail trains, loaded in river barges, and transported down the Mississippi to the New Orleans, Louisiana area. The coal will then be loaded into oceangoing transportation units that will carry it across the Gulf of Mexico to the Crystal River site. The existing coal-receiving facilities at the Crystal River site will be used. This system is designed to unload barges of up to 13,608 metric tons (15,000 tons) capacity. An average of about 3 barges per week will be required.

Fuel oil and gasoline auxiliary fuels will be received at the plant by truck or rail, depending on the supplier.

3.2.3 COAL HANDLING FACILITIES EXISTING FACILITIES

The coal-handling facilities at the plant for Units 1 and 2 include a barge and tug mooring dock, a Dravo clamshell-type barge unloader, a Dravo stacker-reclaimer, and an integrated single-belt conveyor system

connecting the barge unloader and stacker-reclaimer. In addition to the barge unloading facilities, a railcar unloading facility is provided to serve the existing units. This installation includes a railroad loop track for coal delivery and unit train turnaround, an elevated structure for bottom dumping of railcars, and a belt conveyor linking the dump structure with a radial stacker. The radial stacker will generate a coal pile which can be moved by mobile equipment to a reclaim hopper and associated conveyor. The reclaim hopper conveyor will discharge to the transfer house located at the tailpoint of the stockout and reclaim system yard belt. These facilities are physically located south and southeast of the existing units as shown in Figure 3.2-1.

UNITS 4 AND 5 FACILITIES

The existing coal yard and terminal facilities will be modified and expanded to improve the capability and reliability of the system for the four-unit installation. Figure 3.2-2 illustrates schematically how the proposed facilities will be added to existing facilities.

Additions to the existing facilities for Units 4 and 5 will include the following:

1. Two new stockout and reclaim systems for the active storage piles serving the new units;
2. A coal-blending facility;
3. Additional coal-crushing facilities;
4. A series of conveyors linking the unloading, active storage, blending, and crusher facilities in the coal yard area and a dual belt system connecting the coal yard and the silos in each generating unit. The conveyor system would include associated transfer facilities at belt intersections.

The physical locations of the above-listed facilities are shown in Figure 3.2-1.

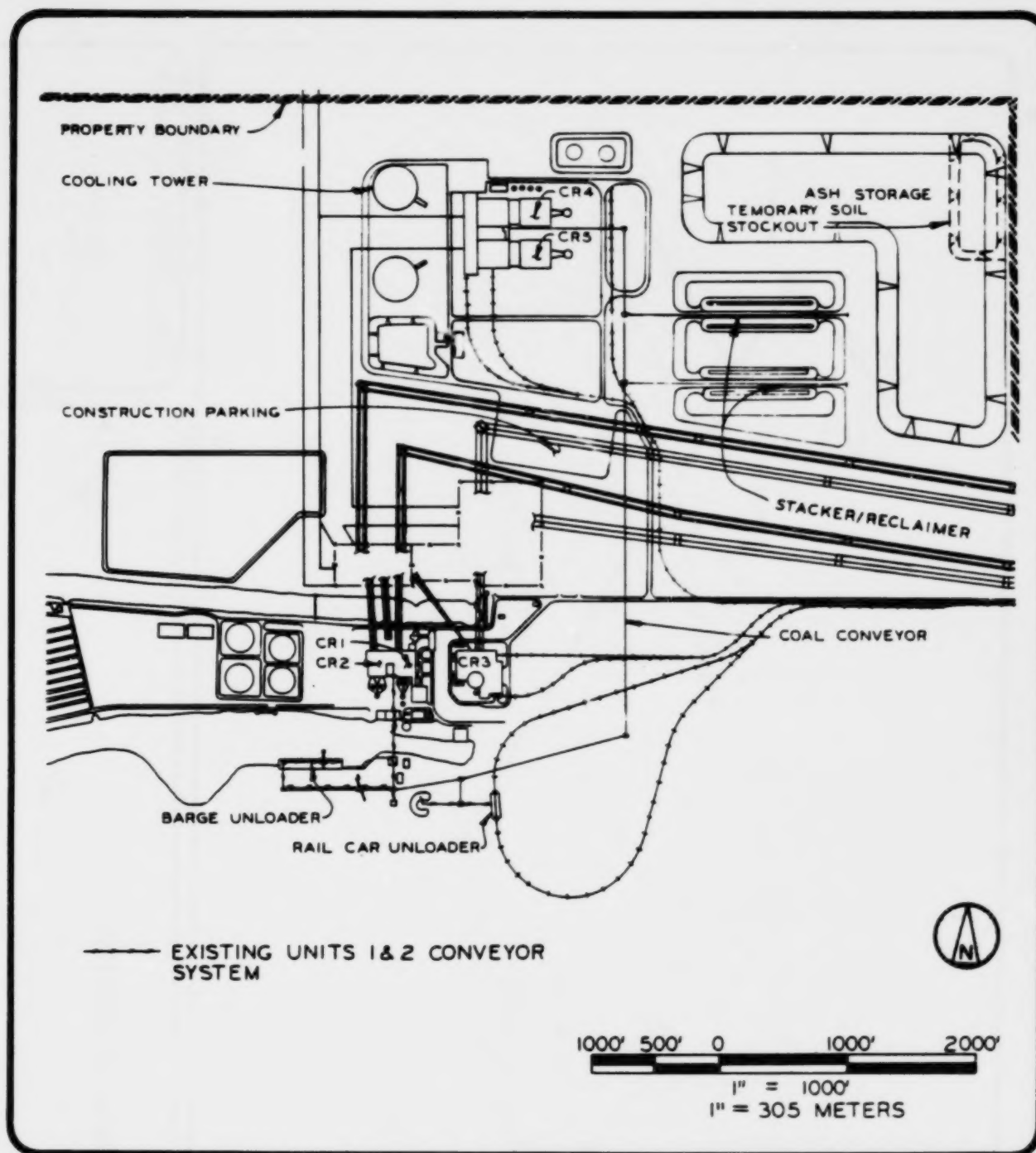


Figure 3.2-1
COAL HANDLING FACILITIES-CRYSTAL RIVER SITE

SOURCE: BLACK AND VEATCH, 1980

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

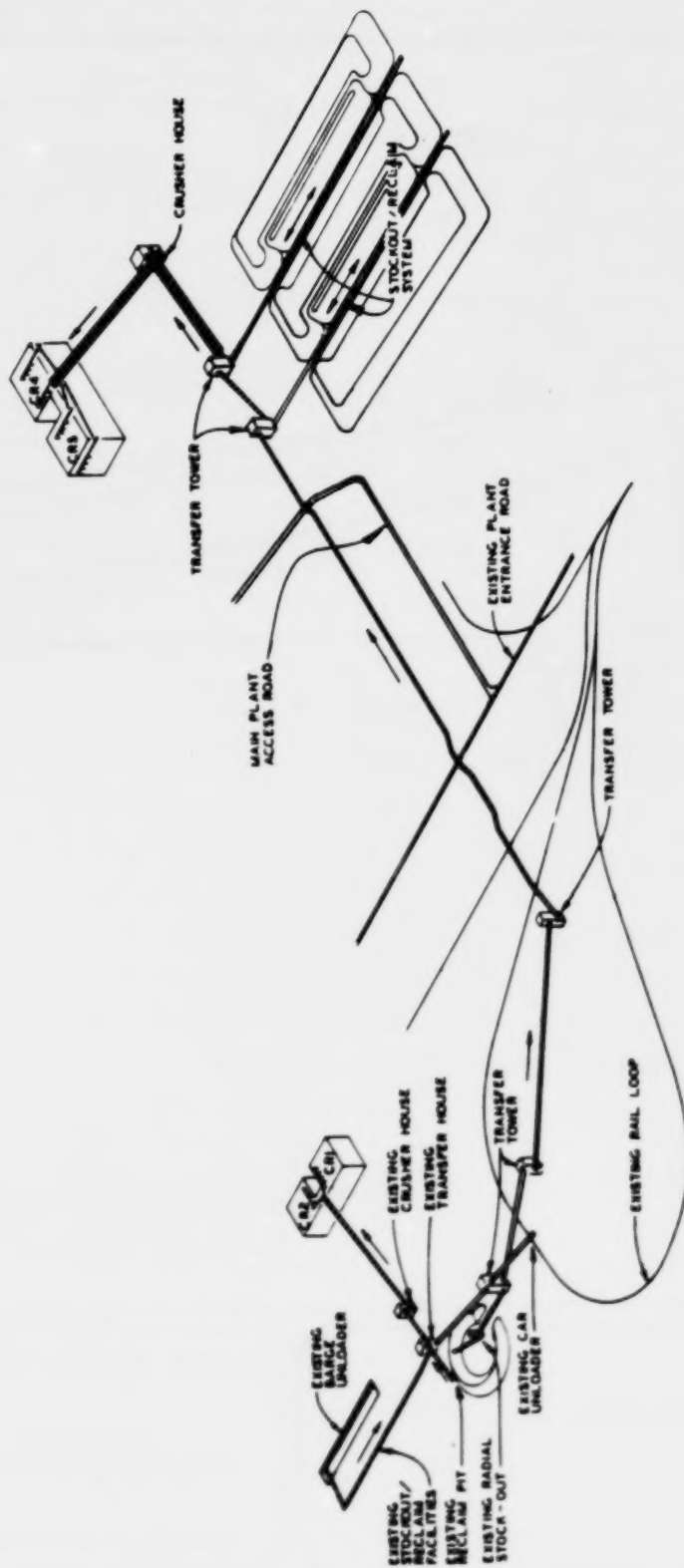


Figure 3.2-2
COAL HANDLING FACILITIES ISOMETRIC

SOURCE: BLACK AND VEATCH, 1960

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

3.2.4 FUEL STORAGE EXISTING FACILITIES

The existing Crystal River Plant Units 1 and 2 utilize three types of coal storage: in-plant, active, and inactive. During normal operation, coal is dumped from the train cars, or removed from the barges, and transported by a system of conveyors and hoppers to the in-plant storage silos. When the in-plant storage silos are full, the coal is diverted to the active storage piles by the stacker-reclaimer. Active storage provides a buffer between rapid but intermittent unloading of coal trains and barges, and slower but steady coal consumption by the plant. The inactive storage is used for periods when the supply of coal is interrupted, such as for equipment failures, labor disputes, or variations between coal purchase contractual commitments.

UNITS 4 AND 5 FACILITIES

Units 4 and 5 will utilize the same three types of coal storage as are used for Units 1 and 2. In-plant storage will be provided for each unit in 6 or 7 silos. Both active and inactive storage will be provided in the area adjacent to the ash storage facility. This area will provide approximately 39,000 metric tons (43,000 tons) of active storage and 776,300 metric tons (885,000 tons) of inactive storage, and will cover approximately 111,000 square meters (27.5 acres). An additional storage of 80,000 square meters (20 acres) will be located adjacent to the stacker-reclaimer system.

The total active storage of 39,000 metric tons (43,000 tons) will provide approximately 8 days' fuel requirements for both units operating at 90 percent capacity. The average resident time for coal in the active storage areas will be 50 to 60 hours, based on the present projections of plant capacity.

The inactive storage piles will be generated by mobile equipment and will provide approximately 776,300 metric tons (855,000 tons) of storage.

Fuel oil will be stored in two, steel, cylindrical-plate storage tanks located within two clay-lined areas north of Unit 4.

3.3

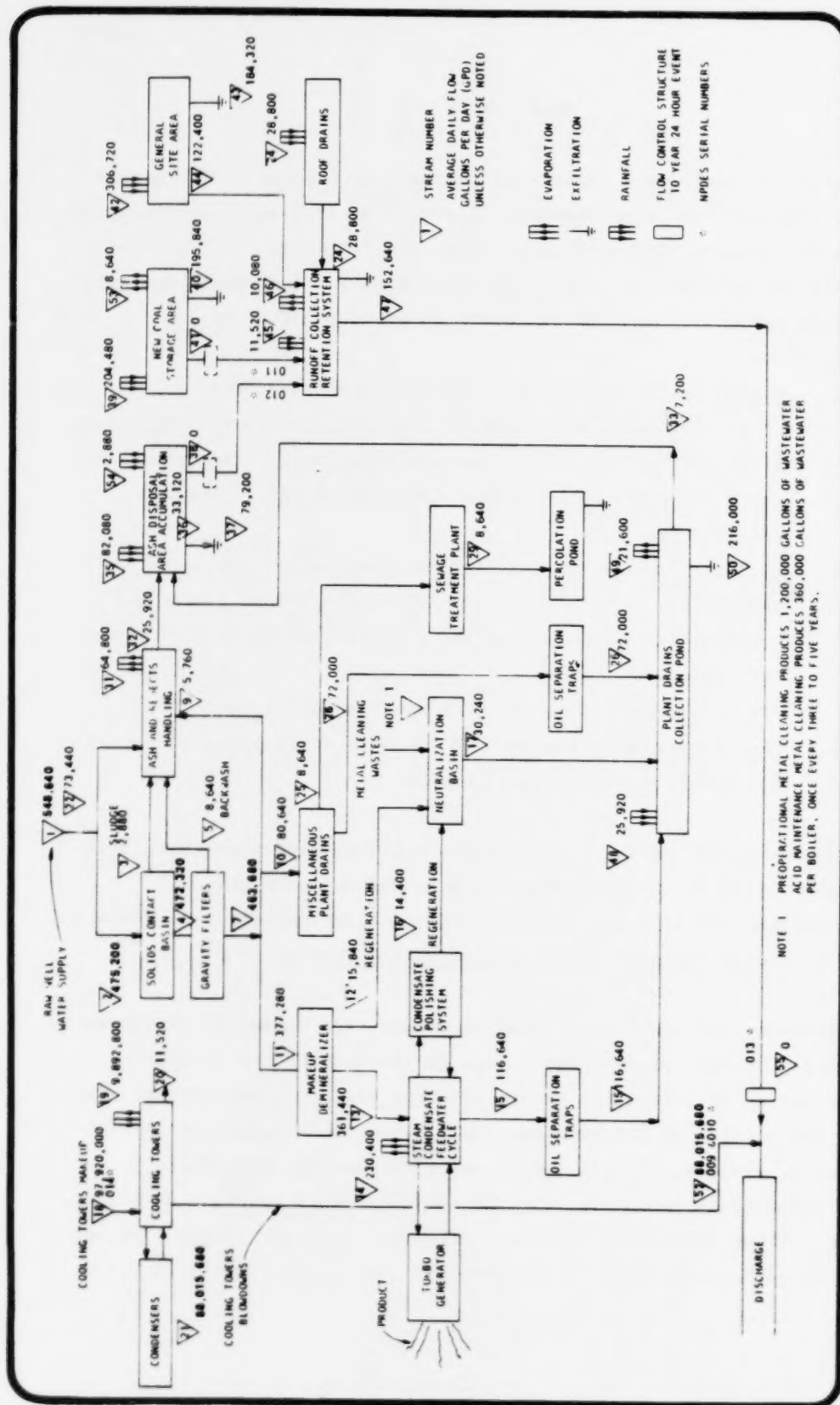
PLANT WATER USE

Water will be used for a variety of purposes at Crystal River Units 4 and 5. Figure 3.3-1 is a schematic flow diagram of plant water supplies, treatment, process consumption, recycle, and discharge. Table 3.3-1 presents the quantity of water used and discharged for normal and peak operating conditions and for temporary shutdown plant conditions as defined below:

1. Normal (or average) operating condition is defined as both generating units operating at the annual average load factor of 66 percent and annual average evaporative conditions, i.e., 21.7°C (71°F) dry bulb temperature and 77 percent relative humidity.
2. Peak (or maximum) operating condition is defined as both generating units operating at 100 percent load factor and maximum atmospheric evaporative conditions existing for the cooling towers during a 24-hour period, i.e., 32.8°C (91°F) dry bulb temperature and 55 percent relative humidity.
3. Temporary shutdown is defined as both units being shut down for maintenance or other reasons.

The quantities for rainfall and evaporation from site areas have been generated using the average annual figures of approximately 1,400 mm/year (55 in/year) for rainfall and 1,220 mm/year (48 in/year) for evaporation (Climatic Atlas of the United States, 1968).

The frequency and duration of peak water-use days cannot be predicted accurately because of dependency both on the weather and on electric system operating conditions external to the Florida Power system. Peak water use occurs, as defined previously, when both generating units operate at 100 percent load factor and when maximum atmospheric evaporative conditions exist for the cooling towers during a 24-hour period. These conditions require a high, dry-bulb air temperature and a large range between wet-bulb and dry-bulb air temperatures (i.e., low



FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 3.3-1
PLANT WATER USE DIAGRAM

SOURCE: Black and Veatch, 1980

Table 3.3-1 Crystal River Units 4 and 5 Site and Plant Water Use

Stream Number	Description	Peak		Normal		Temporary Shutdown	
		dm ³ /s	(gpm)	dm ³ /s	(gpm)	dm ³ /s	(gpm)
1	Raw Well Water Supply	34.2	(543)	24.0	(381)	4.8	(77)
2	Water Pretreatment System Makeup	29.3	(465)	20.8	(330)	4.8	(77)
3	Solids Contact Basin Sludge	0.2	(3)	0.1	(2)	0	(0)
4	Solids Contact Basin Effluent	29.1	(462)	20.7	(328)	4.8	(77)
5	Filter Backwash Wastewater	0.4	(6)	0.4	(6)	0	(0)
7	Gravity Filter Effluent	28.7	(456)	20.3	(322)	4.8	(77)
9	Ash Handling System Service Water Uses	0.3	(4)	0.3	(4)	0	(0)
10	Miscellaneous Station and Potable Water Uses	3.5	(56)	3.5	(56)	3.5	(56)
11	Demineralizer Makeup	24.9	(396)	16.5	(262)	1.3	(21)
12	Demineralizer Regeneration Wastes	1.0	(16)	0.7	(11)	0.7	(11)
13	Condensate-Feedwater-Steam Cycle Makeup	23.9	(380)	15.8	(251)	0.6	(10)
14	Steam Cycle Evaporative Losses						

Table 3.3-1 Crystal River Units 4 and 5 Site and Plant Water Use, (Continued, page 2 of 3)

Stream Number	Description	Peak		Normal		Temporary Shutdown	
		dm ³ /s	(gpm)	dm ³ /s	(gpm)	dm ³ /s	(gpm)
24	Rainfall to Roof Drains	1.3	(20)	1.3	(20)	1.3	(20)
25	Sanitary Wastes	0.4	(6)	0.4	(6)	0.4	(6)
26	Miscellaneous Plant Drains	3.2	(50)	3.2	(50)	3.2	(50)
29	Sewage Treatment Plant Effluent	0.4	(6)	0.4	(6)	0.4	(6)
31	Bottom Ash Hopper Evaporation	4.2	(67)	2.9	(45)	0	(0)
32	Water Entrained in Ash from Ash Handling	1.6	(24)	1.1	(18)	0	(0)
33	Water for Ash Dust Suppression and Compaction	0.4	(7)	0.3	(5)	0	(0)
35	Active Ash Storage Area Rainfall	3.6	(57)	3.6	(57)	3.6	(57)
36	Active Ash Storage Area Water Accumulation	2.0	(31)	1.4	(23)	0	(0)
37	Active Ash Storage Area Exfiltration	3.5	(55)	3.5	(55)	3.5	(55)
38	Active Ash Storage Area Runoff to Collection Ditch System (NPDES 012)	0	(0)	0	(0)	0	(0)
39	New Coal Storage Area Rainfall	9.0	(142)	9.0	(142)	9.0	(142)
40	New Coal Storage Area Exfiltration	8.6	(136)	8.6	(136)	8.6	(136)
41	New Coal Storage Area Runoff to Runoff Collection and Retention System (RCRS) (NPDES 011)	0	(0)	0	(0)	0	(0)
42	General Site Area Rainfall	13.4	(213)	13.4	(213)	13.4	(213)
43	General Site Area Exfiltration	8.1	(128)	8.1	(128)	8.1	(128)
44	General Site Area Runoff to Runoff Collection and Retention System	5.3	(85)	5.3	(85)	5.3	(85)
45	Direct Rainfall on Runoff Collection and Retention System	0.5	(8)	0.5	(8)	0.5	(8)

Table 3.3-1 Crystal River Units 4 and 5 Site and Plant Water Use, (Continued, page 3 of 3)

Stream Number	Description	Peak		Normal		Temporary Shutdown	
		dm ³ /s	(gpm)	dm ³ /s	(gpm)	dm ³ /s	(gpm)
46	Runoff Collection and Retention System Evaporation	0.4	(7)	0.4	(7)	0.4	(7)
47	Runoff Collection and Retention System Exfiltration	6.7	(106)	6.7	(106)	6.7	(106)
48	Plant Drains Collection Pond Rainfall	1.1	(18)	1.1	(18)	1.1	(18)
49	Plant Drains Collection Pond Evaporation	1.0	(15)	1.0	(15)	1.0	(15)
50	Plant Drains Collection Pond Exfiltration	12.0	(197)	9.2	(150)	4.5	(74)
51	Plant Drains Collection Pond Overflow	0	(0)	0	(0)	0	(0)
52	Plant Discharge 009 and 010	3,577	(56,707)	3,855	(61,122)	0	(0)
53	New Coal Storage Area Evaporation	0.4	(6)	0.4	(6)	0.4	(6)
54	Active Ash Storage Area Evaporation	0.1	(2)	0.1	(2)	0.1	(2)
55	Runoff Collection and Retention System Discharge 013	0	(0)	0	(0)	0	(0)

* Based on 1.1 to 1.2 cycles of concentration.

† "Peak" flows are less than "normal" flows because "peak" and "normal" refer to plant operating conditions, not flow conditions. Utilization of the constant rate makeup system results in makeup flow being constant regardless of unit load or ambient conditions. When a generating unit is at 100 percent load, more circulating water is evaporated than at 66 percent load when ambient conditions remain the same. Since the makeup flow is constant, cooling tower blowdown flow is thus greater at 66 percent load factor (normal) than at 100 percent factor (peak).

Note: During heavy rainfall events of greater than 10-year, 24-hour occurrence, overflow from the runoff retention and collection systems will discharge to the discharge cooling canal for Crystal River Units 1, 2, and 3.

Sources: Black and Veatch, 1980.
Environmental Science and Engineering, Inc., 1978.

FPCR4/5-TSD3.1/R3-3.2
3/4/80

humidity). These atmospheric conditions are most likely to occur for intermittent periods during the months of April through September.

3.3.1 WATER SOURCES

The water required to operate Crystal River Units 4 and 5 will be obtained from two primary sources, sea water and ground water.

GROUND WATER

Raw ground water for plant fresh water uses will be obtained from a well field along the Florida Power Corporation Central Florida transmission line right-of-way. A maximum design flow of $130 \text{ dm}^3/\text{second}$ (2,100 gpm, 3 mgd) is required to guarantee freshwater flow rates under all contingencies. The aquifer characteristics obtained from a pumping test (see Section 2.5.1) have indicated that a linear well field consisting of five wells with 500 to 1,000 foot spacing and 420 gpm capacity for each well can supply the plant requirements. This well field would achieve a 3 mgd flow and meet the rules and regulations of the Southwest Florida Water Management District (Chapter 16J F.A.C.). Water quality data representative of the proposed well field water is presented in Table 3.3-2. Water quality data obtained from samples collected prior to and during the aquifer test indicate shallow well water quality similar to that observed in Table 3.3-2. The well water will be pumped to the station to provide makeup to the ash handling system and plant service water.

Raw well water requirements for Units 4 and 5 are a peak flow of about $35.5 \text{ dm}^3/\text{s}$ (563 gpm, 0.81 mgd), and a normal flow of about $25.3 \text{ dm}^3/\text{s}$ (401 gpm, 0.58 mgd). During temporary shutdown of the two units, raw well water demand will be about $4.8 \text{ dm}^3/\text{s}$ (77 gpm, 0.11 mgd).

Table 3.3-2 Well Water Analyses

	Existing Well 3	Existing FPC Well 4		Existing FPC Well 5	
	4/13/76	4/13/76	11/30/76	4/13/76	8/18/76
Calcium*	147	173	160	167	153
Magnesium*	70	74	82	74	82
Sodium*	10	9	9	10	10
M-alkalinity*	208	237	234	232	226
Sulfate*	5	5	5	5	5
Chloride*	13	13	11	13	13
Nitrate*	--	--	--	--	--
Silica†	414	--	4.4	4.3	3.9
Specific Conductance, umhos/cm	435	485	430	475	440
pH	7.8	7.6	7.8	7.6	7.7

*mg/l as CaCO₃.

†mg/l as SiO₂

Source: Black and Veatch, 1976.

GULF COASTAL WATER

Salt water extracted from the existing discharge canal will serve as makeup for the plant cooling towers (circulating water system). The expected quantities of circulating water makeup are defined in Sections 3.3.3 and 3.3.4.

3.3.2 WATER TREATMENT

PLANT SERVICE WATER

Ground water which has been clarified, partially lime-softened, filtered, and chlorinated will be used as plant service water.

A solids, contact-type, clarifier-softener and gravity filter system will be used. Lime, coagulant, and coagulant aids will be used in dosages that have not yet been determined to produce the finished plant service water. Service water will be used as feed water to the demineralization system and for general plant uses including potable water, pump seal water, and ash crusher seal water.

The flow requirements of service water to the demineralization system and other plant uses are indicated in Table 3.3-1 and Figure 3.3-1. Wastes produced by this treatment process are described in Section 3.5.2.

MAKE-UP DEMINERALIZED WATER

Demineralized water is plant service water which has been further processed to a high quality suitable for use as makeup to the condensate-feedwater-steam cycle. The demineralization process will consist of ion exchange by three cation-anion exchanger pairs with degasification after the primary anion exchanger.

The expected peak flow to the demineralization system is $24.9 \text{ dm}^3/\text{s}$ (396 gpm, 0.57 mgd) and the expected normal flow is $16.5 \text{ dm}^3/\text{s}$ (262 gpm, 0.38 mgd). During temporary shutdown of the units, the only demineralized water requirement will be that required for regeneration of the demineralization and condensate polishing systems ion exchange resins. Wastes produced by regeneration are described in Section 3.5.3.

CONDENSATE POLISHING SYSTEM

A condensate polishing system is planned for removal of suspended and dissolved solids from the condensate. This technology will result in maintenance of a higher quality water in the condensate-feedwater-steam cycle and will extend the interval of steam generator cleaning to a period of three to five years.

This system will consist of three mixed-bed (cation and anion) exchangers per unit. Assuming that each resin bed will be regenerated 50 times per year, this system will require an annual average flow of 38 liters (10 gallons) per minute of demineralized water for regeneration. The wastes produced by regeneration are described in Section 3.5.

3.3.3 STATION CONSUMPTIVE USES

Consumptive use of fresh and salt waters are primarily due to evaporation, blowdown, and drift losses from the plant processes, losses due to storage in waste sludges and solids, and evaporation and exfiltration of stormwater runoff from surfaces and storage areas.

COOLING TOWERS

Makeup to the plant cooling towers (circulating water systems) will be Gulf Coastal salt water pumped from the existing discharge canal for Crystal River Units 1, 2, and 3. This water is required to replace circulating water lost by evaporation, drift, and blowdown (discharge of water to maintain water quality to in turn maintain the cleanliness and efficiency of the heat rejection system). Cooling tower makeup will be treated with chemical additives to control algae growth and scaling, as described in Section 3.5.

The expected peak and normal cooling tower makeup requirement is approximately $4,289 \text{ dm}^3/\text{s}$ (68,000 gpm, 97.9 mgd) based on constant rate makeup pumpage. During temporary shutdown, no makeup water will be required for the plant cooling towers.

Cooling tower consumptive use from evaporation and drift at peak conditions will be $712 \text{ dm}^3/\text{s}$ (11,280 gpm, 16.2 mgd), and $0.8 \text{ dm}^3/\text{s}$ (13 gpm, 18,720 gpd), respectively, and $433 \text{ dm}^3/\text{s}$ (6,870 gpm, 9.9 mgd), and $0.5 \text{ dm}^3/\text{s}$ (8 gpm, 11,520 gpd) for normal conditions.

STEAM-CONDENSATE-FEEDWATER CYCLE WATER USE

Consumptive water uses for the steam cycle, including steam soot-blowing, boiler blowdown, and miscellaneous evaporative cycle losses,

will be approximately 23 dm³/s (368 gpm) at the peak condition and 15 dm³/s (241 gpm, 0.35 mgd) at the normal condition. There will be no consumptive water uses for the steam cycle during temporary shutdown.

ASH AND REJECTS HANDLING SYSTEM WATER USE

Consumptive water uses for the ash and rejects handling systems include evaporative losses from the bottom hopper, water accumulated in the solid ash and rejects material in the ash landfill, and evaporative and seepage losses from this ash landfill area. The flows for these consumptive uses at the peak, normal, and temporary shutdown conditions are indicated in Table 3.3-1. Make-up water used in the hydraulic ash and rejects handling systems will be raw well water. Water pretreatment system sludges dewatered in the ash water settling tanks will also provide make-up water.

Precipitator, economizer, and gas recirculation dust collector ash will be handled dry. Bottom ash, mill rejects (pyrites), and the calcium carbonate sludge contained in the water pretreatment wastewater will be dewatered prior to storage in an above-grade landfill area, as described in Section 3.6. Water will be recycled to the hydraulic ash-sludging systems. Plant wastewater from the plant drains collection pond will be utilized for dust suppression and compaction in the ash landfill area. Approximately 1.4 dm³/s (23 gpm, 33,120 gpd) of water will be stored in the ash landfill at normal rates and 2.0 dm³/s (31 gpm, 44,640 gpd) at peak rates.

SANITARY WATER USE

The maximum consumption of plant service water for potable and sanitary uses will occur with Unit 4 operating and Unit 5 under construction. An estimated maximum consumption of 1.1 dm³/s (26,000 gpd) is expected.

During commercial operation of Units 4 and 5, an estimated 26 m³ (6,900 gpd) of water will be consumed by the operating crew, temporary assigned personnel, and visitors.

MISCELLANEOUS PROCESS WATER USE

Normal plant cleaning and maintenance activities, equipment and pipe leakage, and relief valve drains will result in an estimated 3.1 dm³/s (50 gpm, 72,000 gpd) consumptive use for peak and normal conditions.

DEMINERALIZED REGENERATION WATER USE

The demineralized water makeup system and the condensate polishing system ion exchange resins must be regenerated periodically. Water requirements for regeneration are 1.0 dm³/s (16 gpm, 23,040 gpd) and 0.7 dm³/s (12 gpm, 17,280 gpd), respectively for peak use and 0.7 d³/s (11 gpm, 15,840 gpd) and 0.6 dm³/s (10 gpm, 14,400 gpd) for normal use.

PLANT SERVICE WATER TREATMENT

Sludge from the solids contact basin and backwash from the gravity filters consume approximately 0.6 dm³/s (9 gpm, 12,960 gpd) at peak operation and 0.5 dm³/s (8 gpm, 11,520 gpd) under normal operating conditions. This water is recycled to the ash and rejects handling system as make-up water.

3.4

HEAT DISSIPATION SYSTEM

3.4.1 COOLING SYSTEM DESCRIPTION

Each generating unit has a main turbine cooling system and an auxiliary equipment cooling system that will utilize a recirculating water system with a natural draft cooling tower for final heat dissipation. The major components of the cooling system for each unit include one hyperbolic natural draft cooling tower, three horizontal circulating water pumps, condenser, circulating water piping, auxiliary cooling water heat exchangers, a common discharge structure, and a common make-up water intake structure with traveling screens, pumps and piping.

Each cooling tower will be located approximately 162 meters (530 feet) west of its associated turbine building. Each tower will be approximately 113 meters (370 feet) in diameter at the base and 134 meters (440 feet) high.

The main steam cycle for each unit will reject 3.5×10^{12} joules ($3,300 \times 10^6$ Btu) per hour, and the auxiliary equipment will reject approximately 0.2×10^{12} joules (200×10^6 Btu) per hour at full load operating conditions. The total heat load for both main units and auxiliary units at full load operating conditions will be 7.4×10^{12} joules ($7,000 \times 10^6$ Btu) per hour.

The cooling towers will be designed to reject to the atmosphere the total heat load for all units at full load operating conditions. The following design conditions have been selected:

Cooling Range	14.2°C (24.6°F)
Approach	6.7°C (12°F)
Wet Bulb	26.1°C (79°F)

The salt water intake structure serving both units will be located on the north bank of the existing cooling water discharge canal as shown in Figure 3.10-1. The structure will be designed to supply a flow of 68,000 gpm. The structure will be approximately 50 feet wide and will be divided into three cells. Each inlet cell will be equipped with a half capacity (34,000 gpm) pump, a 13-foot traveling screen and a high pressure screen wash pump (Figure 3.4-1 and 3.4-2). The mesh size for

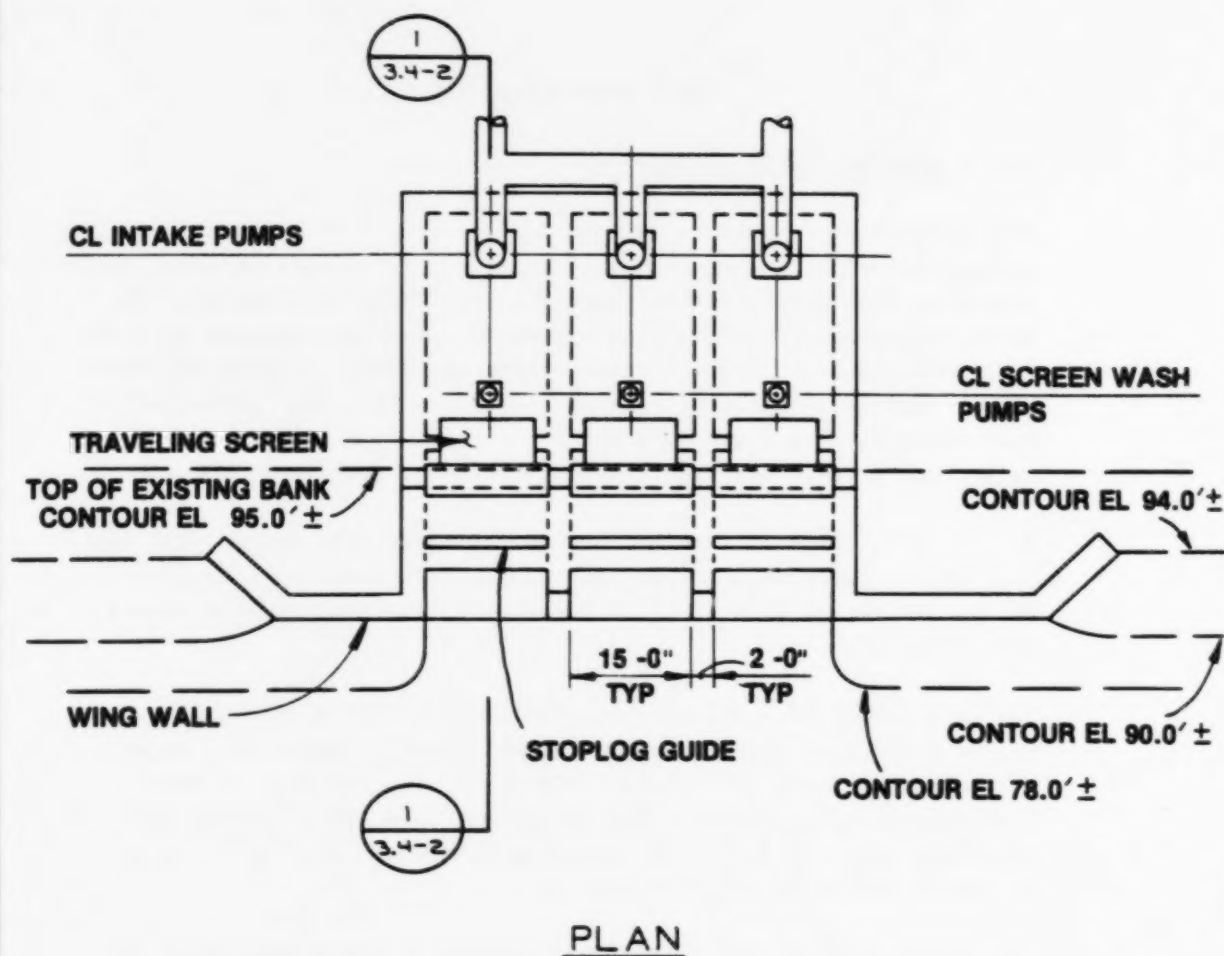


Figure 3.4-1

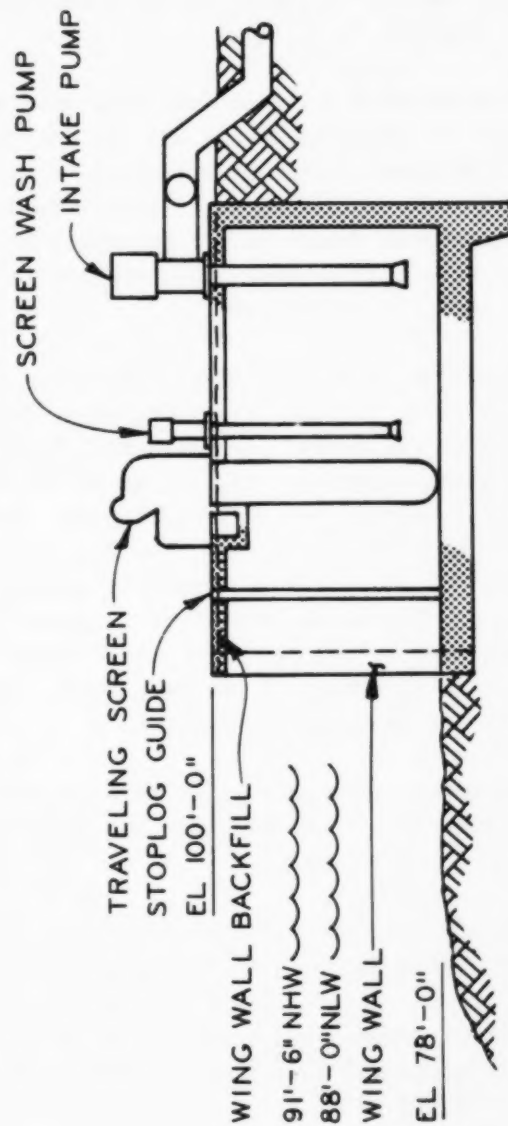
COOLING TOWER MAKE-UP INTAKE STRUCTURE

SOURCE: BLACK AND VEATCH, 1980

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA



SECTION I

Figure 3.4-2

COOLING TOWER MAKE-UP INTAKE STRUCTURE

SOURCE: BLACK AND VEATCH, 1980

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

the traveling screen is 3/8 inch. The water velocity entering the structure at low water level and maximum flow will not exceed 0.5 feet per second. Two pumps will be capable of supplying the total makeup for both units operating at full load.

Each travelling screen is provided with a screen wash pump with a design flow of 325 gallons per minute for cleaning debris off the individual screens. A travelling screen backwash system is activated by a differential level sensor that continuously monitors water levels on both sides of the screen. If the backwash system is not activated by the differential level controller within 24 hours of the previous period of operation, a timer will also energize the system.

When a start signal is generated by either the level controller or the timer, the screen wash pump is first started, and then, after a specified time delay, the traveling screen itself is activated. Spray water is taken from the associated intake pump cell downstream of the screens and pumped through the travelling screen debris spray piping. Each cleaning cycle is about 10 to 20 minutes in length. No fish baskets or fish sprays are provided. The debris is cleaned from the screens and washed into a trash trough which carries the debris to a basket located on the west side of the intake pump structure. The basket traps the debris but allows the flush water to return to the west intake pump cell outside of the screen. The basket is cleaned manually.

Stop logs will be provided to permit each cell to be isolated and dewatered when required. Provisions will be made for the installation of trash racks, if they are found to be needed.

Cooling tower blowdown (NPDES 009 and 010) will be taken from the cold side of the circulating water system and will be discharged into the existing discharge canal for Crystal River Units 1, 2, and 3. NPDES numbers refer to discharge serial numbers as listed in the draft NPDES permit for Units 4 and 5. The maximum 2-hour average temperature of this discharge will be 35.6°C (96°F).

Cooling tower makeup will be at a constant rate regardless of generating unit load. The cycles of concentration of the circulating water will therefore vary between 1.1 and 1.2, depending on the cooling tower evaporation rate.

3.4.2 COOLING WATER DESCRIPTION

Gulf Coastal salt water will be used to replace cooling tower losses due to blowdown, evaporation, and drift. The water use for both units is shown in Table 3.3-1.

The average monthly seawater temperatures for cooling water intake and the discharge canals for once-through cooling systems from Crystal River Units 1, 2, and 3 are presented in Table 3.4-1. The temperature of the discharge canal water represents the temperature of cooling tower makeup water. The expected range of cooling tower blowdown temperatures from Crystal River Units 4 and 5 is presented in Table 3.4-2.

Quality data for salt water in the area is presented in Table 3.4-3. The expected quality of the circulating water blowdown is shown in Table 3.4-4.

SCALE AND CORROSION CONTROL

Chemical corrosion inhibitors will not be used. Salt water makeup will be treated by an alkaline-organic phosphate method of conditioning that will conform to the following quality control limits:

pH	8.0 to 8.5
M-Alk	200 mg/l
Calcium Hardness as CaCO_3	1,200 mg/l

A proprietary organic phosphate scale inhibitor will be used as a chelate to prevent excess scale formation. Mechanical, on-line condenser tube cleaning systems also will be used to control scale formation and biological growths. Periodic sulfuric acid treatment will be used for descaling. Dosages will be determined based on operating experience.

There will be a residual phosphate concentration of up to 10 mg/l in the blowdown as a result of using an organic phosphate scale inhibitor.

Table 3.4-1 Monthly Inlet and Discharge Sea Water Temperatures for
Crystal River Units 1, 2, and 3

Month	Intake Canal Average Temperature		Discharge Canal Average Temperature*	
	[°] F	[°] C	[°] F	[°] C
January	57	13.9	71.5	21.9
February	62	16.7	76.5	24.7
March	56	18.3	79.5	26.4
April	75	23.9	89.5	31.9
May	79	26.1	93.5	34.2
June	84	30.0	98.5	36.9
July	85	31.7	99.5	37.5
August	85	29.4	99.5	37.5
September	83	28.3	97.5	36.4
October	75	26.1	89.5	31.9
November	66	18.9	80.5	26.9
December	60	15.6	74.5	23.6

* Based on Units 1, 2, and 3 operating at maximum capability.

Source: Black and Veatch, 1978.

Table 3.4-2 Temperature Range of Cooling Tower Blowdown for Crystal River Units 4 and 5

Month	Lowest		Highest	
	[°] F	[°] C	[°] F	[°] C
January	49	9.4	86	30.0
February	49	9.4	86	30.0
March	55	12.8	88	31.1
April	62	16.7	90	32.2
May	70	21.1	90	32.2
June	76	24.4	96	35.6†
July	83	28.3	96	35.6†
August	83	28.3	96	35.6†
September	76	24.4	92	33.3
October	64	17.8	90	32.2
November	53	11.7	89	31.7
December	51	10.6	88	31.1

* Based on Units 1, 2, and 3 operating at maximum capability.

† These represent maximum 2-hour average temperatures.

Source: Black and Veatch, 1980.

Table 3.4-3 Gulf Coastal Salt Water Quality Data

	Range (mg/l)
Total Dissolved Solids	15,008 - 36,080
Vol. Dissolved Solids	2,348 - 7,884
Chloride as Cl	7,990 - 17,090
Calcium Hardness	610 - 1,000
BOD ₅	0 - 15
COD	0 - 328
Total Iron	0 - 4.6
Total Copper	0 - 0.59
Total Zinc	0 - 0.15
Total Boron	0 - 5.9
Total Chromium	0 - 0.11
Total Lead	0 - 0.42
Total Arsenic	0 - Trace
Total Mercury	0 - 0.8
Turbidity	0 - 80
pH	7.5 - 8.2
Conductivity (umhos/cm)	23,100 - 49,500

NOTE: Values derived from monthly grab samples at four locations in existing intake and discharge cooling water canals over a sampling period of one year. Calcium hardness data obtained separately.

Source: Florida Power Corporation, 1977.

Table 3.4-4 Quality of Cooling Tower Blowdown for Crystal River Plant
Units 4 and 5

Constituent	Cooling Tower Blowdown
Ca, mg/l as CaCO ₃	1,200
Mg, mg/l as CaCO ₃	5,330
Na, mg/l as CaCO ₃	24,024
M Alk, mg/l as CaCO ₃	157
SO ₄ , mg/l as CaCO ₃	2,909
Cl, mg/l as CaCO ₃	27,587
NO ₃ , mg/l as CaCO ₃	1
SiO ₂ , mg/l as such	1
TSS, mg/l as such	30
Cl ₂ , mg/l as such	0.2 average
	0.5 maximum
T-PO ₄ , mg/l as P	10
pH	8.0 to 8.5
Maximum 2-Hour Average Temperature, °C (°F)	35.6° (96°)

Source: Black and Veatch, 1980.

There will be a residual phosphate concentration of up to 10 mg/l in the blowdown as a result of using an organic phosphate scale inhibitor.

BIOLOGICAL CONTROL

The circulating water will be shock chlorinated to control the growth of fouling organisms, algae and bacterial slimes in the condenser and cooling tower. Shock chlorination will be carefully controlled to prevent the chlorination of two units simultaneously and will be limited to one to three periods per day per unit of chlorine solution feed. Actual solution feed will be limited to 20 minutes or less per period. The chlorine feed rates will be controlled to limit the maximum concentration of total residual chlorine in the blowdown (NPDES 009 and 010) to meet the NPDES limitations of 0.10 mg/l, and/or dechlorination facilities will be required.

The following is a summary of the anticipated chemical dosages for scale and biological control:

	<u>Peak Operation</u>		<u>Normal Operation</u>	
	kg/day	lb/day	kg/day	lb/day
Scale Inhibitor	5,121	11,289	3,118	6,875
Chlorine	212	466	212	466
66° Baume'	Intermittent use to be determined based on operational experience.			
Sulfuric Acid				

3.5

CHEMICAL AND BIOCIDES WASTES

This section describes the wastewaters generated during start-up, operation, and maintenance phases of various plant systems, and planned methods for treatment and disposal.

The expected quantity and quality of each chemical and biocide utilized and of any resulting waste streams are presented in the following subsections. A summary of expected chemical additive feed rates for various plant streams at 100 percent (peak) and 66 percent (normal) plant loads is given in Figure 3.5-1. The legend which accompanies Figure 3.5-1 is found on the page following the figure (Page 3-51).

The EPA has promulgated maximum allowable discharge standards for new steam electric power generating units (40 CFR 423). These regulations set forth specific discharge limitations for separate plant processes (eg. cooling tower blowdown, low volume wastes). The parameters covered in this regulation are pH, suspended solids, and oil and grease for most processes. Metal cleaning wastes and boiler blowdown have additional standards for copper and iron. Cooling tower blowdown standards cover residual chlorine and corrosion inhibitors.

Effluent guidelines and standards for steam electric generating are summarized in Table 3.4-5.

Table 3.4-5. U.S. Environmental Protection Agency Standards of Performance for New Sources: Maximum Allowable Discharge Concentrations by Waste Source^{1,2}

Effluent Characteristics										
Waste Source	Total Suspended Solids		Oil & Grease		pH	PCB ⁴	Copper, Total	Iron, Total	Free Available Chlorine ⁵	Zinc, Chromium, Phosphorus, and Other Corrosion Inhibitors
	Daily Max.	Daily Ave.	Daily Max.	Daily Ave.	Allow. Range		Max.	Daily Max.	Max. nation Instantaneous Ave.	Daily Max. Ave.
1. All discharges						6.0-9.0	ND ⁶			
2. Low volume wastes ^{7*}	100mg/1	30mg/1	20mg/1	15mg/1						
3. Bottom ash transport water ^{8*}	100mg/1	30mg/1	20mg/1	15mg/1						
4. Fly ash transport water ^{8*}	ND ⁶ , 9	ND ⁶ , 9	ND ⁶ , 9	ND ⁶ , 9						
5. Metal cleaning wastes and boiler blowdown ^{9*}	100mg/1	30mg/1	20mg/1	15mg/1			1 mg/1	1 mg/1	1 mg/1	
6. Cooling tower blowdown ¹⁰										
7. Main Condensate ^{8*}										
8. Material storage runoff ¹²	50mg/1 ⁹	50mg/1 ⁹			6.0-9.0					
9. Construction runoff ^{12*}	50mg/1 ⁹	50mg/1 ⁹			6.0-9.0					
									0.5mg/1	0.2mg/1
									ND ⁶	ND ⁶
										ND 6, 9, 11

FOOTNOTES FOR TABLE 3.4-5.

- 1The quantity of pollutants discharged from waste sources 1-6 shall not exceed the quantity determined by multiplying the flow from the waste source times the concentration in the table.
- 2In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property attributable to each controlled waste source shall not exceed the specified limitation for that waste source.
- 3Daily Maximum: Maximum 24-hour value; Daily Average: Average value for 30 consecutive days.
- 4PCB: Polychlorinated biphenyl compounds.
- 5Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator that the units in a particular location cannot operate at or below this level of chlorination.
- 6NDA: No detectable amount and ND: No discharge.
- 7Include, but are not limited to waste waters from wet scrubber air pollution control systems, ion exchange water treatment systems, water treatment evaporator blowdown, laboratory and sampling streams, floor drainage, cooling tower basin cleaning wastes, and blowdown from recirculating house service water systems.
- 8The quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of bottom ash transport water times the above concentrations and dividing the product by 20.
- 9Limitations remanded and set aside by the United States Court of Appeals for the Fourth Circuit on July 16, 1976.
- 10Blowdown shall mean the minimum discharge of recirculating cooling water for the purpose of discharging materials contained in the process, the further buildup of which would cause concentrations or amounts exceeding limits established by best engineering practice.
- 11There shall be no discharge of heat from the main condensers except heat may be discharged in blowdown from recirculated cooling water systems provided the temperature at which the blowdown is discharged does not exceed at any time the lowest temperature of recirculated cooling water prior to the addition of the makeup water.
- 12Any untreated overflow from facilities, constructed and operated to treat the volume of material storage runoff and construction runoff which results from a 10-year, 24-hour rainfall event shall not be subject to the pH and total suspended solids limitations stipulated for this waste source.

pH measured in standard units
mg/l—milligrams per liter

*These standards do not apply to the Crystal River Units 4 and 5, as designed.

Source: U.S. Environmental Protection Agency "Steam Electric Power Generating Point Source Category: Effluent Guidelines and Standards," Federal Register, Volume 39, No. 196, October 8, 1974. 40 CFR Part 423.

LEGEND FOR FIGURE 3.5-1

Key	Chemical	Kg/d (PPD)	
		66% LF	100% LF
A	Chlorine	212 (466)	212 (466)
B	66° Baume Sulfuric Acid	N/A	N/A
C	Organic Phosphate	3,118 (6,875)	5,121 (11,289)
D	Lime [93% Ca(OH ₂)]	320 (700)	440 (970)
E	Polyelectrolyte	0.8 (1.7)	1.0 (2.3)
F	Chlorine	2.2 (6)	4.1 (9)
G	100% Sodium Hydroxide	110 (235)	160 (366)
H	66° Baume Sulfuric Acid	340 (740)	510 (1,120)
I	100% Sodium Hydroxide	50 (110)	75 (160)
J	66° Baume Sulfuric Acid	160 (360)	240 (540)
K	100% Sodium Hydroxide	100 (210)	150 (325)
L	Hydrazine	1.4 (3)	1.8 (4)
M	Ammonia	27 (60)	41 (90)
N	Trisodium Phosphate	0.4 (1)	0.4 (1)
O	Chlorine	0.4 (1)	0.4 (1)

3.5.1 CIRCULATING WATER SYSTEM

Cooling tower blowdown discharges are discussed in Section 3.4. Operational controls are described that will limit free available chlorine or total residual chlorine concentrations to less than those required by 40 CFR, Section 423, as discussed in Section 3.4.

No additional treatment of cooling tower blowdown is planned prior to its discharge into the existing discharge canal. The use of corrosion inhibitors or biocides other than chlorine is not planned.

3.5.2 STEAM CYCLE LOSSES

Steam cycle liquid losses (leaks from pumps, piping, and valves in the cycle, plus boiler blowdown) at peak and normal conditions will be 7.8 and 5.1 liters per second (123 and 81 gallons per minute) and 670 and 440 cubic meters (0.18 and 0.12 million gallons) per day, respectively. Plant floor and equipment drains will collect and discharge wastewaters from normal plant cleaning and maintenance activities, equipment and pipe leakage, and relief valve drains at an estimated rate of 3.2 liters per second (50 gallons per minute) and 270 cubic meters (72,000 gallons) per day during peak and normal load plant conditions.

Hydrazine, ammonia, and trisodium phosphate will be fed to Units 4 and 5 condensate-feedwater-steam cycles to minimize scaling and corrosion. Hydrazine consumption is estimated at 1.8 kilograms (4 pounds) per day at peak plant load and 1.4 kilograms (3 pounds) per day at normal plant load, both as 100 percent hydrazine. Ammonia consumption is estimated to be 41 kilograms (90 pounds) per day at peak plant load and 27 kilograms (60 pounds) per day at normal plant load, both as 100 percent ammonia. Trisodium phosphate consumption is estimated to be less than 0.5 kilogram (1 pound) per day at all plant loads. The above wastewaters will be discharged to the plant drains collection pond.

3.5.3 ASH TRANSPORT WATER

Water will be used to hydraulically pump and transport bottom ash and pyrites from collection hoppers to ash dewatering bins as described in Section 3.6.2. Reclaimed water will be recycled back to the collection hoppers for reuse. Water used in the system will either evaporate or will be accumulated in the ash and land-filled. Ash transport water will not be discharged to surface waters.

3.5.4 METAL CLEANING WASTES

Metal cleaning wastes are any cleaning compounds, rinse waters, and other waterborne residues derived from cleaning metal process equipment such as boiler tubes, air preheaters, and boiler firesides. These wastes typically contain concentrations of iron, copper, TSS, and oil and grease.

PREOPERATIONAL CLEANING

The watersides of the boiler and preboiler systems, including piping, will be alkaline-and acid-cleaned and rinsed prior to initial start-up to remove contaminants remaining from construction and installation. Alkaline cleaning will use a sodium phosphate solution and subsequent flushing water. Preoperational acid cleaning will use a solution of hydroxyacetic-formic acid (HAF) for the preboiler system, and either inhibited hydrochloric acid or HAF for the boiler. An acid neutralization step is required, followed by flushing with demineralized water. Approximately 4,500 cubic meters (1,200,000 gallons) of wastewater will be generated over a period of several days and discharged to the neutralization basin.

MAINTENANCE ACID CLEANING

Acid cleaning is a maintenance procedure which must be performed at 3- to 5-year intervals to remove accumulated scale from the boiler. This operation requires complete shut-down of one unit and will generate approximately 1,400 cubic meters (360,000 gallons) of wastewater that will be discharged to the neutralization basin over a period of five days.

MAINTENANCE BOILER FIRESIDE AND AIR HEATER WASHINGS

Boiler fireside and air heater water washes are maintenance procedures which may be performed at 1- to 3-year intervals to remove accumulated

FPCR4/5-TSD3.1/R3-5.6
2/28/80

deposits from the equipment. Wastewater from these washings will be directed to the ash-handling system.

3.5.5 LOW-VOLUME WASTE SOURCES

Low-volume waste sources include ion exchange regeneration wastes, laboratory chemical wastes, cooling tower basin cleaning wastes, floor drains, and plant service water treatment system wastes.

PLANT SERVICE WATER SYSTEM

The plant service water pretreatment system will treat raw well water for makeup to the demineralization system and service water system, including potable water uses. Pretreatment will include lime softening, clarification, filtration, and chlorination. The chemicals expected to be used are hydrated lime [93 percent Ca(OH)_2], chlorine, and a polyelectrolyte. The expected quantities of chemicals used during peak and normal load plant operation, respectively, are: hydrated lime, 440 kilograms (970 pounds) per day and 320 kilograms (700 pounds) per day; chlorine, 4 kilograms (9 pounds) and 3 kilograms (6 pounds) per day; and polyelectrolyte, 1.0 kilogram (2.3 pounds) and 0.8 kilograms (1.7 pounds) per day.

The plant service water pretreatment system will produce a calcium carbonate sludge from the solids contact unit and a backwash water from the gravity filters that will require disposal. Approximately 1.3 kilograms (2.9 pounds) of precipitate will be formed per 3.785 cubic meters (1,000 gallons) throughout for the quality of raw well water specified in Table 3.4-1.

Assuming a 5-percent solids concentration in the solids contact unit sludge, a flow of 0.126 liters per second (2 gallons per minute) 10.9 cubic meters (2,880 gallons) per day will result at the annual average service water demand of 22 liters per second (350 gallons per minute) or 1,900 cubic meters (0.5 million gallons) per day. Gravity filter backwash will generate an estimated 0.38 liters per second (6 gallons per minute) or 32.7 cubic meters (8,640 gallons) per day, assuming that they are backwashed weekly.

The total wastewater from the water pretreatment system is expected to average 0.5 liters per second (8 gallons per minute) or 43.6 cubic feet (11,520 gallons) per day. This wastewater will be pumped to the bottom ash dewatering bins where the suspended solids will be separated from the fluid and disposed with the bottom ash solids to a landfill as discussed in Section 3.6. An estimated 663.7 kilograms (1,462 pounds) per day of pretreatment system solids will be disposed of in this manner. The liquid portion of the water pretreatment system wastewater will be used as makeup to the bottom ash sluice system. Discharge of water pretreatment system wastewater to navigable water will not occur.

DEMINERALIZATION SYSTEM

The demineralization system will process pretreated well water to provide high-quality water suitable for use as makeup to the condensate-feedwater-steam cycles and other miscellaneous uses requiring high-quality water. The wastewater from this system will consist of unreacted sulfuric acid and sodium hydroxide plus the sodium and sulfate salts of the ions removed from the ion exchange resins during regeneration. The average daily regenerant chemicals required are estimated at 161 kilograms (355 pounds) per day of 100 percent sodium hydroxide and 508 kilograms (1,120 pounds) per day of 66° Baume sulfuric acid at peak load plant conditions. At normal plant load, the caustic and acid requirements are approximately 107 kilograms (235 pounds) per day and 336 kilograms (740 pounds) per day, respectively.

The regenerant wastewaters are expected to average 1.0 and 0.69 liters per second (16 and 11 gallons per minute) for peak and normal plant loads, respectively, and will be routed to the neutralization basin where the wastewater pH will be adjusted to between 6.5 and 9.0. Neutralized wastewaters will then be discharged to the plant drains collection pond which will not discharge to surface waters.

CONDENSATE POLISHING SYSTEM

The condensate polishing system will process condensate, providing protection to the steam cycle against condenser tube leaks or poor-quality makeup, and allowing faster unit restarts. Chemicals utilized for regeneration of this system will be the same as those used for the demineralization system: sodium hydroxide and sulfuric acid. Based on full-flow polishing of both units' condensate, the daily regenerant chemicals required are estimated at 75 kilograms (160 pounds) per day of 100 percent sodium hydroxide and 250 kilograms (540 pounds) per day 66° Baume sulfuric acid at peak load. At normal load, the caustic and acid requirements are approximately 50 kilograms (110 pounds) per day for 160 kilograms (360 pounds) per day, respectively.

The condensate polishing system wastewaters are similar to those produced in the demineralization system. The regenerant wastewaters are expected to average 0.76 and 0.63 liters per second (12 and 10 gallons per minute) for peak and normal plant loads, respectively, and will also be routed to the neutralization basin for pH adjustment. An estimated 23 kilograms to 34 kilograms (50 pounds to 75 pounds) per day of 100 percent sodium hydroxide will be required for neutralization of these wastewaters. These wastewaters are discharged to the plant drains collection pond in the same manner as the demineralization system wastewaters.

CHEMICAL LABORATORY WASTES

The principal chemical reagents to be used in the laboratory will include sodium and ammonium hydroxide; hydrochloric, nitric, sulfuric, and ethylenediaminetetraacetic acids; and sodium carbonate. Small quantities of various other chemicals will also be used for analytical testing.

The total quantity of chemical laboratory wastes is expected to be 0.38 cubic meters (100 gallons) per day, independent of generating plant load. The chemical laboratory wastes will be collected and discharged to the plant drains collection pond via the neutralization basin.

3.5.6 MATERIAL STORAGE RUNOFF

Material storage runoff was defined in October 1974 as the rainfall runoff from or through any coal, ash, or other material storage pile. On June 3, 1980, EPA revised the regulations to include standards for coal pile runoff only. However, both coal and ash pile runoff at the proposed site will be flow-segregated from general site drainage, and contained in a pond capable of confining the quantity of water from a 10-year, 24-hour storm event.

NEW COAL STORAGE AREA

A new coal storage area is located southeast of the proposed new units. Approximately 19 hectares (47 acres) will be dedicated to active and inactive coal storage as well as the operation area required by conveyors, transfer stations, and stacker-reclaimers. The area will be diked and drained by a 1.2-hectare (3-acre) perimeter drainage ditch. The storage area will not be lined with impervious material. The drainage system for the area will be designed to hold the volume of rainfall runoff resulting from the 21.3-centimeter (8.37-inch) 10-year, 24-hour rainfall event. The stored rainfall will be disposed of by evaporation and exfiltration. Excess rainfall will be discharged into the runoff collection ditch system via an overflow structure (NPDES 011). A discussion of discharge from the runoff collection ditch system is presented in Section 3.10.1.

The low-sulfur coal to be burned in Units 4 and 5 is expected to have low leachate characteristics with the pyritic sulfur content less than 0.2 percent. If, after analysis, the pyritic sulfur content is determined to be greater than 0.2 percent, a minimum of 2 feet of compacted clay will be placed under the coal pile. The clay will have permeability characteristics of montmorillonite.

ACTIVE ASH STORAGE AREA

The ash storage area is located east of the proposed site of the new units. The total ash storage area is 38 hectares (95 acres). It will be operated as a landfill and will be designed to have approximately 8.1 hectares (20 acres) in active use at any one time as described in Section 3.6.2.

The active area will be designed and operated to retain the quantity of rainfall resulting from the 21.3-centimeter (8.37-inch), 10-year, 24-hour rainfall event within a diked area. The stored runoff will evaporate and exfiltrate. Excess rainfall will discharge into the runoff collection ditch system via an overflow structure (NPDES 012).

An on-site Leachate Monitoring and Testing Program near the ash disposal area is discussed in Section 6.2 of this document. This study will determine lining requirements for the disposal area based on local geophysical characteristics. See Section 3.10.1 for a discussion of discharge from the runoff collection ditch system.

3.5.7 TRANSFORMER OIL SPILL PREVENTION AND RECOVERY

The main and auxiliary transformers for both units will be mounted on concrete surfaces sloped to area drains in a manner to provide swift drainage of spilled transformer oil. Drain piping will be routed to an oil-water separator structure (Figure 3.5-2). The piping and separator will be sized to safely handle and recover a complete oil spill from the largest single transformer for either unit plus inflow from the 21.3-centimeter (8.37-inch), 10-year, 24-hour rainfall event and inflow from the fire protection deluge system.

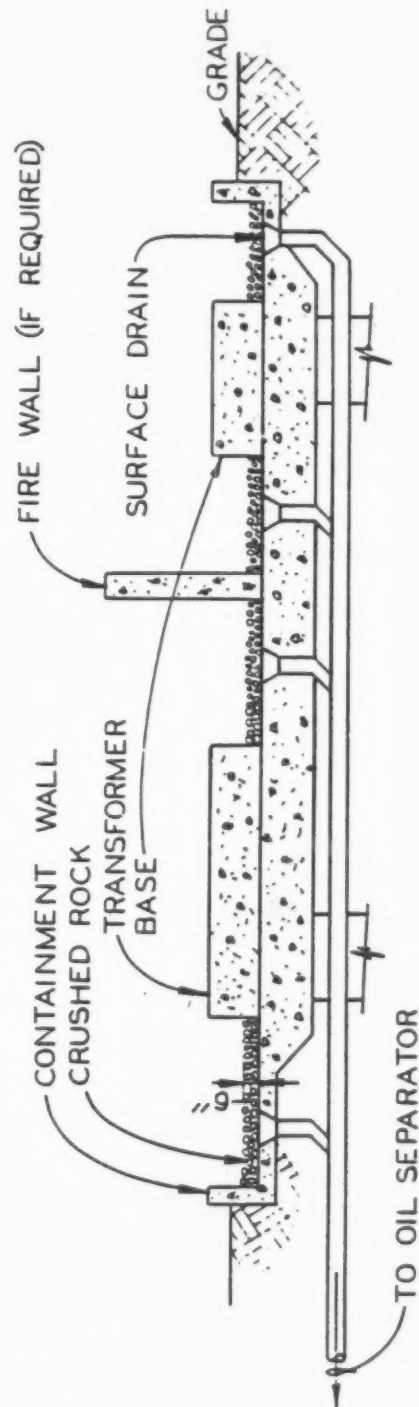


Figure 3.5-2
TRANSFORMER OIL RECOVERY

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

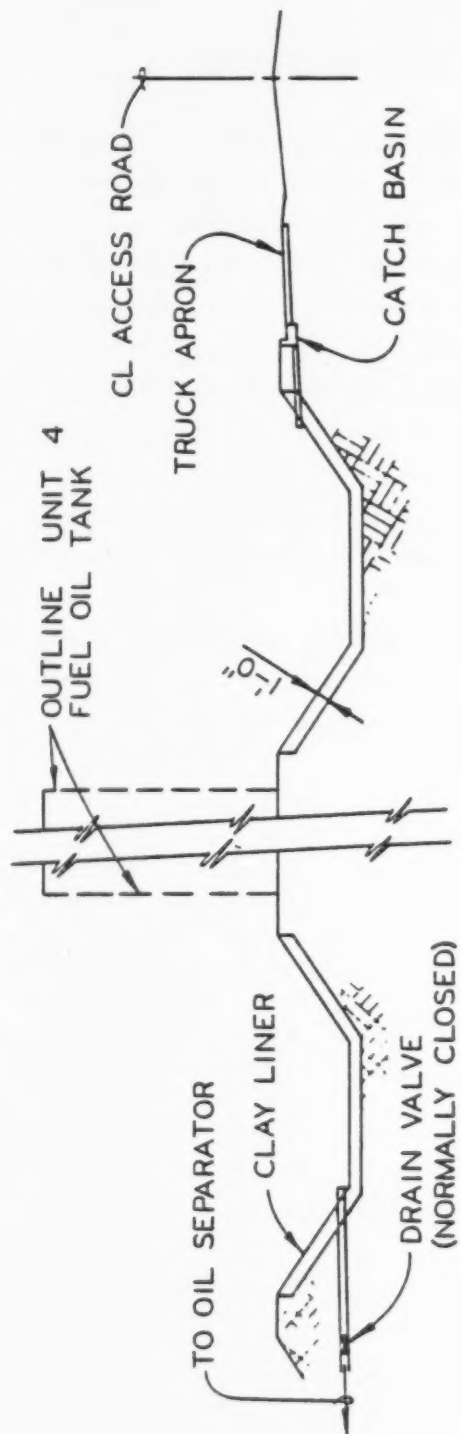
CITRUS COUNTY, FLORIDA

SOURCE: BLACK AND VEATCH, 1976

3.5.8 FUEL OIL SPILL PREVENTION AND RECOVERY

Aboveground fuel oil storage tanks are required. The tanks are located north of Crystal River Unit 4. A fuel unloading facility is also required. Fuel oil storage tanks will be diked in a manner to provide sufficient capacity for containment of the entire volume of the tank in the event of a spill, plus a reserve capacity for impounded rainfall from the 21.3-centimeter (8.37-inch), 10-year, 24-hour design storm. A 30-centimeter (1-foot) thick clay blanket will form the liner for the bottom and interior slopes of the fuel oil containment dike. A buried drain pipe and valve will provide drainage of the containment dike. Rainfall drainage will be routed through an oil separator structure to remove oil from normal leakage and small spills (see Figure 3.5-3).

The truck unloading area will have a reinforced concrete apron that will be curbed and the surface sloped to drain into a catch basin. The catch basin will drain to the oil separator structure.



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 3.5-3
FUEL OIL RECOVERY

3.5.9 WASTE TREATMENT AND DISPOSAL SYSTEMS

GENERAL CONCEPT

Segregation and reuse of waste streams is the primary concept behind the design of the waste treatment and disposal systems for the proposed facility. Wastewater from the plant drains collection pond is used for ash dust suppression and compaction; low-volume wastes and metal-cleaning wastes are segregated, pretreated, and discharged to the plant drains collection pond; material storage pile runoff is segregated from general site runoff and settled (see Sections 3.5.6 and 3.10.1); oil-water separators are used to recover oil spills (see Section 3.5.8), treat rainfall runoff, and pretreat process wastewaters.

NEUTRALIZATION BASIN

A neutralization basin with a volume of 380 cubic meters (100,000 gallons) is planned for metal-cleaning wastes (preoperational and operational), ion exchange regeneration wastes, and laboratory chemical wastes. This basin will be used for neutralization of wastes on a batch basis. The basin will be sized to contain the largest volume of chemical cleaning solution wastes expected in one batch.

The basin will be constructed of reinforced concrete with a chemical-resistant membrane overlaid with acid-resistant brick and mortar. A mixer will be mounted on a walkway spanning the open-topped basin. Sulfuric acid and sodium hydroxide will be available from the demineralizer system regeneration equipment for neutralization of the basin's contents.

The basin will require several days to fill during normal plant operations, as discharges will consist primarily of ion-exchange regeneration wastes. These wastes will tend to be self-neutralizing and will require

minimal chemical addition. Neutralized regeneration wastes will be routed to the plant drains collection pond to evaporate and exfiltrate.

Batch neutralization of preoperational chemical-cleaning wastes will produce approximately 3,200 kilograms (7,000 pounds) of precipitated metal hydroxides. Acid cleaning will produce about 950 kilograms (2,100 pounds) of precipitate every 3 to 5 years. The precipitate and neutralized supernatant will be discharged to the plant drains collection pond. Prior to discharge of the precipitate to the plant drains collection pond, a determination will be made as to whether the material is hazardous. If this precipitate is determined to be hazardous, it will be disposed of in an approved hazardous waste landfill. If this material is not hazardous, it will be discharged to the plant drains collection pond.

3.5.10 PLANT DRAINS COLLECTION POND

The plant drains collection pond influents will include neutralization basin wastewaters, steam cycle liquid losses, and low-volume wastes.

The plant drains collection pond is designed to contain all wastewater influents and direct rainfall. The area and volume of the plant drains collection pond are 2.6 hectares (6.5 acres) and 24,000 cubic meters (19.5 acre-feet), respectively. This volume is equivalent to over four times the volume of a 10-year, 24-hour rainfall event of 21.3 centimeters (8.37 inches). There will be no discharge from the pond, as evaporation and exfiltration exceed the wastewater influents and maximum expected rainfall.

3.6

SANITARY AND OTHER WASTE SYSTEMS

3.6.1 SANITARY WASTE SYSTEM

The sewage treatment plant will be an 11.3-cubic meter (30,000-gallon) per day packaged, activated sludge unit which employs the extended aeration process method of treatment. The facility will be designed to achieve 90 percent reduction of BOD₅ and suspended solids. The process equipment will be installed in concrete basins, with separate and parallel aeration and clarification sections. A comminutor will be provided to reduce the size of solids at the inlet to the plant. A chlorine contact chamber and a gas solution chlorination system will be provided for disinfection of the effluent. Chlorine consumption is estimated to be .9 kilograms (2 pounds) per day independent of the plant generating load.

The maximum hydraulic and biological loading will occur with Unit 4 operating and Unit 5 under construction. Under these conditions, an estimated maximum of 97 cubic meters (25,750 gallons) per day of sewage containing 25 kilograms (57 pounds) of BOD₅ was calculated as follows:

100 permanent personnel @ 35 gpd	3,500 gpd
50 temporary personnel @ 25 gpd	1,250 gpd
40 visitors @ 25 gpd	1,000 gpd
1,000 construction personnel @ 20 gpd	20,000 gpd
	<u>25,750 gpd</u>

During commercial operation of Units 4 and 5, the sewage treatment plant will treat an estimated 26 cubic meters (8,640 gallons) of sewage per day containing approximately 8 kilograms (18 pounds) of BOD₅, based on an estimated operating crew of 132, plus temporary assigned personnel and visitors independent of electric generating plant load. The design of the sewage system will allow efficient operation during periods of

normal load that occur during commercial operation of Units 4 and 5, by dewatering one aeration chamber-clarifier chamber pair.

The disinfected effluent from the sewage treatment plant will be routed to a dedicated percolation pond. There will be no discharge to surface waters from this source. Hydraulic loading rates to this pond will be designed to allow complete percolation of the effluent. Waste sludge from the sewage treatment plant will be disposed off-site in an approved manner by a contract sludge disposal service, or on-site in the ash disposal area. The quantities of sludge generated will be relatively small.

3.6.2 SOLID WASTE HANDLING AND DISPOSAL

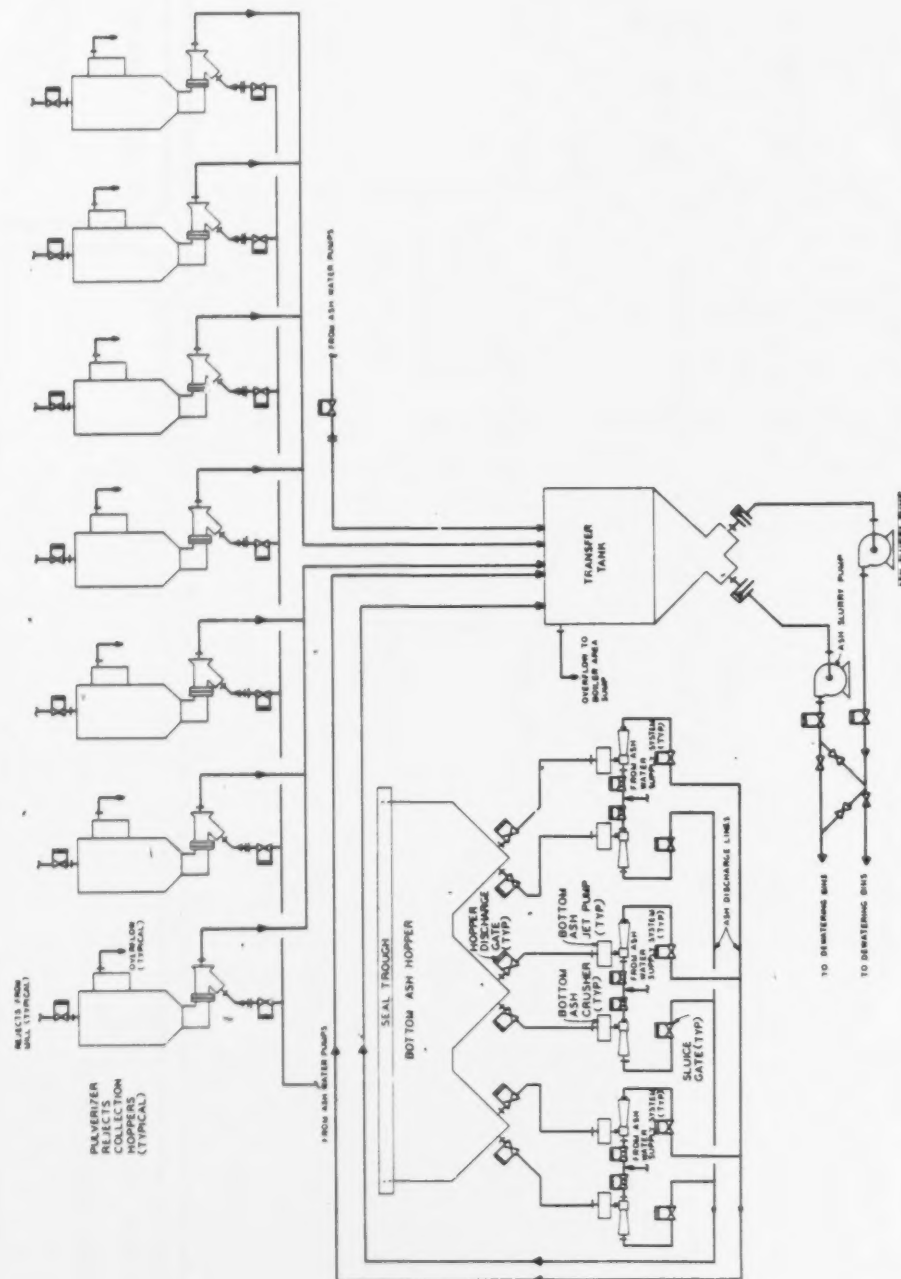
Solid wastes resulting from plant operation will include bottom ash, coal pulverizer rejects, economizer ash, gas recirculation dust collector ash, precipitator fly ash, and water pretreatment system sludge.

Bottom ash will be collected in a water-sealed hopper and hydraulically sluiced to an intermediate transfer tank. Coal pulverizer rejects (pyrites) will be collected in small hoppers adjacent to each pulverizer. The pyrites will be conveyed hydraulically from each pulverizer hopper to the same intermediate transfer tank used for bottom ash. The bottom ash and pyrites will then be pumped with centrifugal slurry pumps to the ash dewatering bins. Figure 3.6-1 summarizes schematically the bottom ash and pulverizer rejects collection systems. The water pretreatment sludge will be pumped directly to the ash water settling tank.

In the dewatering bins, the ash in the ash-water mixtures will be settled and the transport water removed through gravity decanting and dewatering elements. The transport water will be reclaimed, clarified, and returned to the ash handling system. No discharge to surface waters will occur. A schematic diagram of the ash dewatering and transport water reclaim systems is shown in Figure 3.6-2.

Economizer ash, gas recirculation dust collector ash, and fly ash collected in the precipitator hoppers will be pneumatically conveyed by a vacuum system to a storage silo located on the plant site. The vacuum required to remove and transport the fly ash will be produced by mechanical vacuum pumps. A schematic arrangement of the fly ash collection system is shown in Figure 3.6-3.

The expected quantity of solids for disposal, based on both units operating at average capacity, will be approximately 784,000 kilograms (1,730,000 pounds) per day, while at peak capacity, 1,187,000 kilograms



FLORIDA POWER CORPORATION

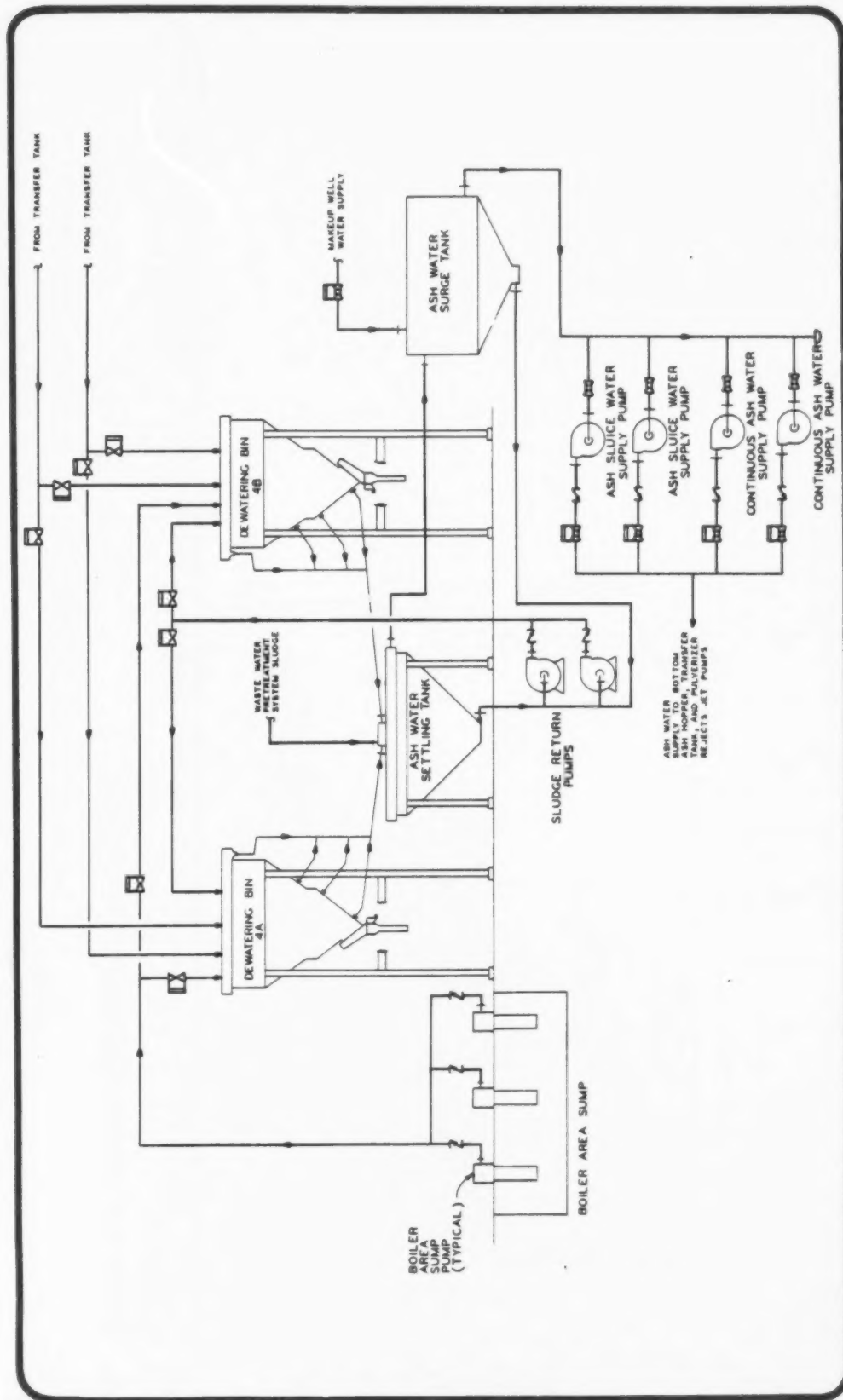
PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 3.6-1

BOTTOM ASH AND PULVERIZER REJECTS HANDLING

SOURCE: BLACK AND VEATCH, 1980



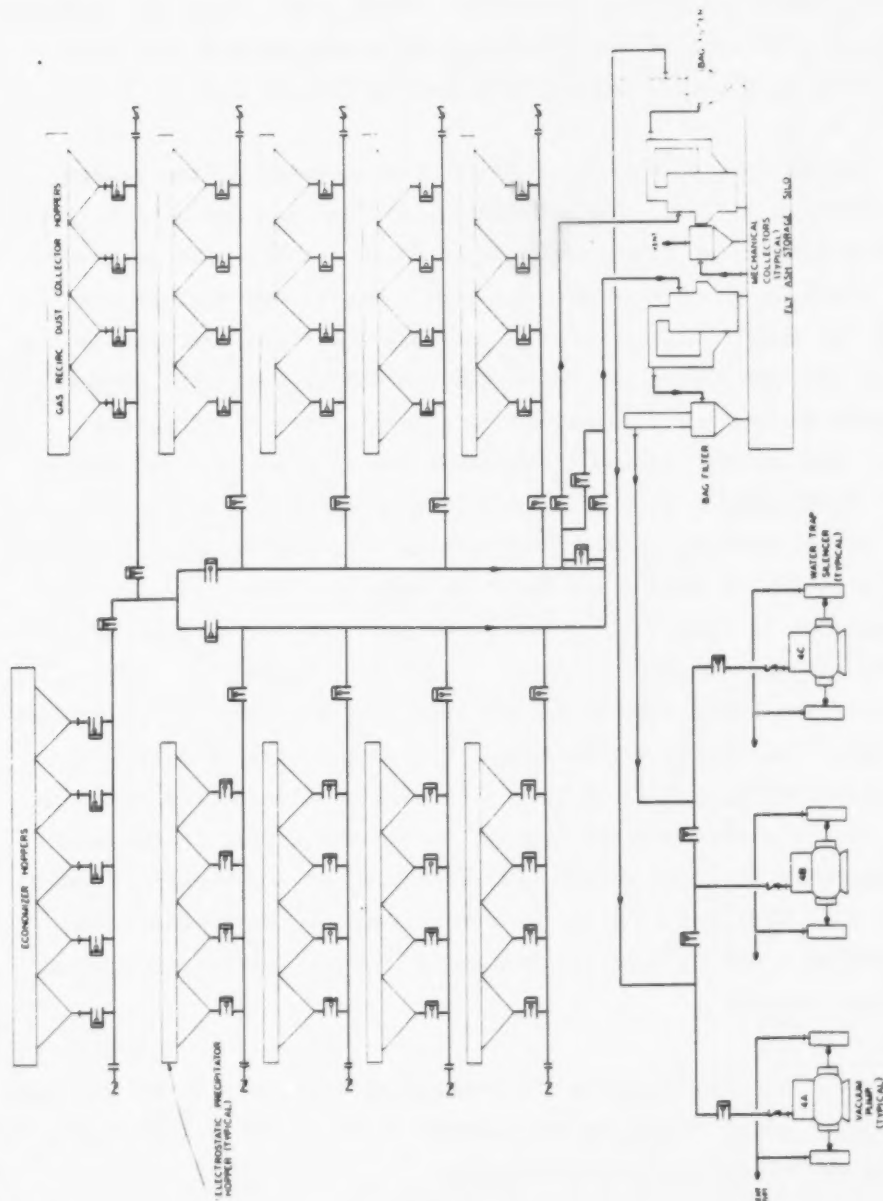
FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 3.6-2
ASH DEWATERING BINS

SOURCE: BLACK AND VEATCH, 1980.



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 3.6-3
FLY ASH HANDLING

SOURCE: BLACK AND VEATCH, 1980

(2,620,000 pounds) per day are expected. Table 3.6-1 lists the expected quantities of each type of solid waste at both average and peak load factors, based on the fuel supply described in Section 3.2.

Dewatered bottom ash, pulverizer rejects, pretreatment system sludge, dry precipitation fly ash, dry economizer ash, and dry gas recirculation ash produced during the operating life of Units 4 and 5 will be transported by truck to an on-site storage area. Provisions will be made in the design for possible future use of conveyors to transport the ash to the on-site storage area. The total storage development will consist of approximately 38 hectares (95 acres) at a total depth of 12 meters (40 feet). The storage area will be developed in 8-hectare (20-acre) segments. Each segment will be filled to a height of 12 meters (40 feet) above existing grade. The storage pile slopes will be dressed with soil material of sufficient depth to support vegetation. At the time the segment is developed to design height, the top surface will be sloped for drainage and will be dressed with soil materials. The soil material used for cover will be stockpiled in unused portions of the ash storage area. The active ash storage will be compacted and sloped to insure minimum infiltration. A toe canal will be constructed along the perimeter of the active storage segment to receive surface stormwater runoff. Stormwater runoff (NPDES 012) in excess of a quantity of water equivalent to a 10-year, 24-hour storm event will be diverted to the canal retention system. Refer to Section 3.5.6 for further discussion of stormwater runoff.

A comprehensive Leachate Testing and Monitoring Program will address the characteristics and attenuation of leachate from the Ash Disposal Area. The program is described in Chapter 6.2.3.

The on-site ash storage area will be sufficient for the storage of all bottom ash, pulverizer rejects, economizer ash, gas recirculation dust collector ash, pretreatment system sludge, and precipitator fly ash produced for 24 years of the 30-year operating life of Units 4 and 5.

Table 3.6-1. Crystal River Plant Solid Waste Quantities, Units 4 and 5

Constituent	Average (66%) Capacity		Peak (100%) Capacity	
	Mg/Day	(10 ³ Lb/Day)	(Mg/Day)	(10 ³ Lb/Day)
Bottom Ash*	147	(324)	223	(492)
Economizer Fly Ash*	29	(65)	44	(98)
Precipitator Fly Ash*	560	(1,234)	849	(1,872)
Pulverizer Rejects*	47	(103)	70	(154)
Pretreatment System Solid Waste	.7	(1.5)	(1.0)	(2.1)
Total Solids to Ash Storage	783.7	(1,727.5)	1,187.0	(2,618.1)
Total Volume of Solids to Storage	328 m ³	(18,630 ft ³)		

* Ash and rejects quantities based on design coal blend.

Source: Black and Veatch, 1978.

This conclusion is based on the average generation capacity with the fuel supply described in Section 3.2. Fly ash, economizer ash, and gas recirculation dust collector ash from these units will be handled dry by a common vacuum system. Provisions will be made in the collection system piping to allow the future installation of a separate collection system for economizer and gas recirculation dust collector ash. The separate system would be utilized if it becomes necessary to separate economizer and gas recirculation dust collector ash from fly ash to accommodate fly ash sales. Fly ash could possibly be sold for such purposes as: mineral filler in asphalt paving, additive in concrete and concrete products, Pozzolin in soil stabilization, raw material in lightweight aggregate, grouting agent, fill for development, and agricultural applications. If 26.5 percent of fly ash from Units 4 and 5 is sold, then the on-site storage area will be sufficient for the storage of all ash and pretreatment system sludge for 30 years operating life at average capacity.

3.7

AIR EMISSIONS

3.7.1 DESIGN REQUIREMENTS

STEAM GENERATOR

Crystal River Units 4 and 5 consist of two fossil fuel-fired steam generators. Each unit will operate at an electrical capacity of 695 Mw (gross) and will burn approximately 294,000 kilograms (648,000 pounds) per hour of coal based on the typical coal analysis (Section 3.2). Combustion at this load will produce approximately 3,277,209 kilograms (7,224,887 pounds) per hour of combustion gases which will consist primarily of nitrogen, carbon dioxide, water vapor, oxygen, particulate matter, sulfur dioxide, and nitrogen oxides. The constituents of the combustion gas are shown in Table 3.7-1.

Both the U.S. Environmental Protection Agency and the Florida Department of Environmental Regulation have adopted regulations establishing air pollutant emission rates which are applicable to Crystal River Units 4 and 5. The emission limitations are described in 40 CFR Part 60.40, Standards of Performance for Fossil Fuel-Fired Steam Generators, and Chapter 17-2.04(e)1.F.AC, Rules of the Department of Environmental Regulation (DER). The applicable emission rate limitations from both the EPA and the DER regulations are summarized as follows:

Pollutant	Emission Rate Limitation
Sulfur Dioxide	520 Nanograms per joule (1.2 lb per million Btu)
Particulate Matter	43 Nanograms per joule (0.1 lb per million Btu)
Nitrogen Dioxide	300 Nanograms per joule (0.7 lb per million Btu)
Opacity	20 percent*

*The opacity shall not exceed 20 percent except that 40 percent opacity shall be permissible for not more than 2 minutes in any hour.

Table 3.7-1. Combustion Products*

Combustion Product	Unit 4		Unit 5		Total	
	kg/h	(lb/h)	kg/h	(lb/h)	kg/h	(lb/h)
H ₂ O	195,955	(432,000)	195,955	(432,000)	391,910	(864,000)
CO ₂	634,133	(1,398,000)	634,133	(1,398,000)	(1,398,000)	(2,796,000)
N ₂	2,282,515	(5,032,000)	2,282,515	(5,032,000)	4,565,030	(10,064,000)
O ₂	159,214	(351,000)	159,214	(351,000)	318,428	(702,000)
SO ₂	2,880	(6,350)	2,880	(6,350)	5,760	(12,700)
NO ₂	2,118	(4,670)	2,118	(4,670)	4,236	(9,340)
Cl ₂	91	(200)	91	(200)	182	(400)
	303	(667)	303	(667)	606	(1,334)
TOTAL	3,227,209	(7,224,887)	3,227,209	(7,224,887)	6,554,418	(14,449,774)

*Based on peak coal consumption of 294,000 kilograms (648,000 pounds) per hour per unit, 20 percent excess air at 60 percent relative humidity, and 27°C (80°F) dry bulb (0.013 kilograms of moisture per kilogram of dry air).

Source: Black & Veatch, 1978.

Based on the typical coal analysis and the Standards of Performance for New Stationary Sources, equipment will be installed to control oxides of nitrogen and particulate matter.

The steam generators will be designed to operate such that the oxides of nitrogen emission rate expressed as nitrogen dioxide, will not exceed 300 nanograms of nitrogen dioxide per joule (0.7 pounds of nitrogen dioxide per million Btu) of heat input.

The typical ash content of the coal is about 7.9 percent with a range of 5.8 to 12.0 percent by weight, which corresponds to an ash production rate of about 3,300 nanograms per joule (7.7 pounds per million Btu). The approximate fly ash production, based on 90 percent of the total ash being fly ash is as follows:

<u>Total Ash Production</u>		<u>Fly Ash Production</u>	
percent by weight		Nanograms/joule	(lb/MBtu)
Typical	7.9	2,970	(6.9)
Minimum	5.8	2,180	(5.8)
Maximum	12.0	4,520	(10.5)

A precipitator with 99.6 percent efficiency will be used for each unit to collect fly ash so that particulate emissions do not exceed 43 nanograms/joule (0.1 pounds per million Btu) heat input.

The typical sulfur content of the design coal is about 0.49 percent with a design range of 0.4 to 0.6 percent. Based on 100 percent of the sulfur being converted to sulfur dioxide and a typical coal heating value of 23,850 joules/megagram (10,258 Btu/lb) the typical sulfur dioxide production is about 410 nanograms per joule (0.95 pounds per million Btu) with a range of 34 to 50 nanograms per joule (0.78 to 1.2 pounds per million Btu).

Sulfur dioxide removal is not required since the range of emission rate is within present federal and state regulations which limit the sulfur

dioxide emission rate to 520 nanograms per joule (1.2 pounds per million Btu) heat input.

A stack height of approximately 183 meters (600 feet) and a diameter of 6.86 meters (22.5 feet) for each unit is adequate to satisfy dispersion requirements. Each chimney will be capable of discharging approximately 1,038 m³/s (2,200,000 ACFM) of flue gas at 127°C (260°F) and 28.1 m/s (99.2 f/s). The flue gas flowrate and emissions are presented in Table 3.7-2.

COAL AND ASH HANDLING

The coal and ash handling system will generate particulate matter from handling western coal and dry fly ash. Observed unloading of Western coals at a number of utilities indicates that there is considerable dust emission even though western coals have a relatively high total moisture content. The probable cause of high dust emission is the more friable nature of western sub-bituminous coals as compared to midwestern or eastern bituminous coals. The emissions become more severe as the coal moves through a typical handling system. Natural drying action takes place in handling as the size of the coal is reduced, causing significantly greater dust emissions in transfer and silo areas. The handling of mideastern and eastern coals in the systems does not create as much dust as do western coals, although the emissions are sufficient to require dust-collecting equipment.

The major emission points will be the coal conveyor transfer points, crusher house, coal silos, fly ash silos, fly ash vacuum pump discharge and emergency reclaim hopper.

Coal will be transferred by covered conveyor from the existing coal handling area to Units 4 and 5 storage. At the storage area, coal will be blended and transferred to the crusher house by covered conveyor. Five transfer points are designed in the conveying system.

Table 3.7-2. Flue Gas Flow Rates and Emissions at Peak Load

<u>Heat Input</u>	<u>Unit 4 (695 Mw Gross)</u>	<u>Unit 5 (695 Mw Gross)</u>
GJ/h (10^6 Btu/h)	7,032 (6,665)	7,032 (6,665)
Gas Temp C(F)	126.7°C (260°C)	126.7 (260)
Gas Flow		
kilograms/hour (lb/h)	3,277,209 (7,224,887)	3,277,209 (7,224,887)
acms (ACFM)	1,038 (2,200,000)	1,038 (2,200,000)
Stack Exit Velocity		
meters/second (feet/second)	28.1 (92.2)	28.1 (92.2)
Stack I.D., meters (feet)	6.86 (22.5)	6.86 (22.5)
Stack Height, meters (feet)	182.9 (600)	182.9 (600)
Pollutant Emissions		
SO ₂ , kilograms/hour (pounds/hour)	3,537 (7,798)	3,537 (7,798)
Particulate Emissions		
kilogram/hour pounds/hour	303 (667)	303 (667)

Source: Black & Veatch, 1980.

The crusher house and the in-plant coal storage silos are the remaining coal emission points. In-plant storage will be provided by six or seven silos per unit.

The fly ash will be handled dry to enable possible commercial sale. As a consequence, possible fly ash emission may occur in the storage and transfer areas. Two points of discharge that have been identified are the fly ash silo and fly ash discharge system. Table 3.7-3 presents the applicable regulations for coal and fly ash handling.

Table 3.7-3 Applicable Regulations for Coal and Ash Handling System

Particulate Emission Point	Number of Emission Points	Applicable Regulation	Type of Limitation
Transfer Point	5	Ch. 17-2.04(2)*	Process weight
Coal Crusher	1	Ch. 17-2.04(2)	Process weight
Coal Storage Silos	4	Ch. 17-2.04(2)	Process weight
Fly Ash Silos	2	Ch. 17-2.04(2)	Process weight
Fly Ash Vacuum Pump Discharge	2	Ch. 17-2.04(2)	Process weight
Emergency Reclaim Hopper	1	Ch. 17-2.04(2)	Process weight
Coal Storage Area		Ch. 17-2.04(3)	Fugitive dust
Fly Ash Disposal		Ch. 17-2.04(3)	Fugitive dust

*State of Florida regulations only applicable.

Sources: Black and Veatch, 1980.
Chapter 17-2, Florida Administrative Code.

3.7.2 CONTROL SYSTEMS DESCRIPTION

STEAM GENERATOR

General

Oxides of nitrogen will be controlled by design and operation of the steam generator. Some particulate must be removed from the combustion gas to allow the steam generator to comply with the existing regulations for emissions and ambient air quality. The combustion gas of each unit leaves the steam generator and enters the air heater at about 343.3°C (650°F). The air heater transfers heat from the hot combustion gas to the steam generator combustion air. The combustion gas then enters the precipitator for particulate removal. Based on the upper design ash content and 20 percent opacity limitation, a precipitator of 99.6 percent efficiency is necessary to meet applicable standards. The cleaned combustion gas then passes to the induced draft fans and is discharged via a single 183-meter (600-foot) high stack.

Oxides of Nitrogen Control

In the combustion process, nitrogen oxides (NO_x) are formed in the high temperature regions of the boiler in and around the flame zone by oxidation of both atmospheric nitrogen and nitrogen in the fuel. Formation of NO_x can be reduced by reducing peak combustion temperatures, which is accomplished by limiting the amount of excess air available to the fuel and staging combustion.

NO_x from Units 4 and 5 steam generators will be controlled to meet emission standards by utilizing features to minimize NO_x formation during combustion. These design features will include one or more of the following:

1. Dual register burners (staged combustion);
2. Compartmented windbox (improved combustion control);
3. Large furnace and widely-spaced burners (reduced temperatures);
4. Overfire heat; and
5. Limiting heat input per burner.

The large furnace and widely-spaced burners increase the burner firing zone absorption area and decrease peaking combustion temperatures, thus minimizing NO_x formation.

The steam generators will be designed to operate such that the oxides of nitrogen emission rate expressed as nitrogen dioxide will not exceed 300 nanograms of nitrogen dioxide per joule (0.7 pound of nitrogen per million Btu) of heat input.

Particulate Control

Particulate matter generated during combustion will be removed in the electrostatic precipitator.

The electrostatic precipitator for the new boiler would normally operate with average air heater outlet temperatures of 110°C to 130°C (230°F to 266°F). Wide variations in resistivity could be expected for this temperature range for the fuel listed in Table 3.2-1. The temperature range within the gas stream leaving the air heater might vary as much as 11°C to 17°C (20°F to 30°F) above and below the average temperature. Different sections of the electrostatic precipitator could therefore be expected to experience temperatures varying between 93°C and 149°C (200°F and 300°F). Thus, the electrostatic precipitator could at any given time be experiencing wide variations in particle resistivity. The electrostatic precipitator would be designed with a greater number of fields (greater depth) and larger collecting surface to allow for the variations in resistivity that will be experienced.

Suggested design parameters for the electrostatic precipitator installation are shown in Table 3.7-4.

At full load, the maximum design ash content of the coal, more than 99.6 percent of the fly ash will be removed from the combustion gases leaving the furnace.

Table 3.7-4 Suggested Design Parameters for Electrostatic Precipitator

Precipitator efficiency (%)	99.6	
Gas flow, acms (ACFM)	1,048	(2,221,000)
Gas temperature, C (F)	130	(226)
Gas velocity, meters per second (feet per second)	0.91	(3)
Effective front end area, meters ² (feet ²)	1,146	(12,339)
Plate heights, meters (feet)	9.75	(32)
Effective width, meters (feet)	117.65	(386)
Aspect ratio [four 2.74 meters (9 feet) and one 3.66 meters (12 feet) field]	1.5	
Field depth, meters (feet)	14.63	(48)
Effective volume, meters ³ (feet ³)	16,794	(593,000)
Duct width, meters (inches)	0.23	(9)
Number of ducts	515	
Total plate area, meters ² (feet ²)	146,975	(1,582,000)
Collecting area, meters ² /acms (feet ² /10 ³ ACFM)	140	(712)
Number of transformer rectifiers	80	
Number of bus sections	160	
Total power required, Mw	5.4	
Estimated precipitator dimensions, each (two precipitator/unit)		
Length, meters (feet)	17.68	(58)
Width, meters (feet)	64.01	(210)
Height, meters (feet)	15.24	(50)
Overall height, meters (feet) (including hoppers)	21.34	(70)

Source: Black and Veatch, 1977.

COAL AND ASH HANDLING

General

Control of dust will be accomplished using either of the following methods:

1. Dust suppression by application of a wetting agent, or
2. Dust collection in a dry state by air transport to a bag filter unit.

Wetting agent type dust suppression systems are available, consisting of pre-engineered modules which incorporate both water handling components and automatic spray controls. A typical spray solution contains 3,000 parts of water to one part of an organic ether detergent. The rate of spray application is about 3.4 liters per metric ton (1.2 gallons per ton) of coal which increases total surface moisture by about 0.5 percent.

Dry dust collection is accomplished by removal of dust-laden air from enclosed transfer points into a duct system which terminates in a bag filter unit. The collection process creates a slight negative pressure within enclosed transfer points. This pressure is effective in reducing the expiration of dust along skirt seals, along other points of potential dust leakage, and at points of loading impact in the conveyor system.

At the collection point, over 99 percent collection efficiency can be achieved with a properly maintained bag filter. Bag filters operate by passing dust-laden air through a fabric at low velocity. The fabric is arranged in envelope (pillowcase style) or tubular shapes within the collection areas. Removal is obtained by buildup of a cake or mat on the fabric's dirty air surface. Good collection efficiencies can be maintained for dust particle sizes to 1 micron and smaller.

As dust is collected on the fabric, resistance to air flow increases. Periodically, the fabric is cleaned by rapping, shaking, or air pulse vibration of the bag to drop the bulk of the adhering material to an

underlying collection hopper. Typically, units for coal dust collection are designed with air (cfm) to cloth (square feet) ratios of 7-9 to 1 for air pulse type units and 3-5 to 1 for shaker type units. Fabric material for coal dust collection generally is polypropylene, polyester, or polyesterdacron felt.

Pulse or reverse jet-type removal systems require external, source-of-package unit compressed air systems. Shaker- or rapper-type units are self-contained but are subject to slightly higher maintenance costs for the mechanical linkage systems.

Fabric collectors are limited to air conditions dry enough to prevent condensation or free moisture deposits on the fabric. Bonding tendencies of the moist dust particles gradually seal the fabric, rendering it useless, and eventually lead to bag replacement. The sealing characteristics of coal dust are somewhat variable, depending upon inherent moisture content and chemical composition of the coal, and the presence of inerts (limestone or clay) in the material. When spray systems are used in conjunction with bag filter units, care must be taken in the positioning of spray nozzles (wet type suppression system) to ensure that free moisture is not entrained in the air entering the filter units.

Proposed Control System

The suggested design specifications for the bag filter units are based upon an assumed inlet loading of 0.4 grams/1,000m³/second (13 grams per acfm). An efficiency of 99.9 percent is the recommended performance requirement. Presented in Table 3.7-5 are the estimated emissions from the coal and ash handling discharge points.

Table 3.7-5 Particulate Emissions from Coal and Ash Handling

Source	Number of Discharges	Flow Rate Per Discharge		Emissions Per Discharge	
		m ³ /sec	(cfm)	grams/sec	(lbs/hr)
Transfer Points	5	1.9	(4,100)	0.13	(0.5)
Crusher House	1	7.1	(15,000)	0.2	(1.7)
Coal Storage Silo	4	2.8	(5,900)	0.1	(0.7)
Fly Ash Silo	2	9.0	(19,000)	0.28	(2.2)
Fly Ash Vacuum Pump Discharge	2	1.4	(3,000)	0.04	(0.3)
Emergency Reclaim Hopper	1	3.3	(7,000)	0.1	(0.8)

Source: Black and Veatch, 1978.

Sulfur Dioxide

As indicated earlier, low-sulfur coal will be utilized to meet sulfur dioxide emission limitations. Sufficient space will be provided in the design for flue gas desulfurization (FGD) systems. The use of FGD will require, as a minimum, 800 additional acres for sludge disposal. In the event FGD is necessary, alternate sludge disposal sites will be provided off-site.

3.8

DIRECTLY ASSOCIATED TRANSMISSION LINES

No additional transmission lines are required. Crystal River Units 4 and 5 will be served by the existing transmission line systems.

3.9

DIRECTLY ASSOCIATED FACILITIES

3.9.1 ARRANGEMENT

RAILROAD

Rail access into the Units 4 and 5 complex will be provided from a switch at the existing plant railroad. This railroad will provide for delivery of construction materials and equipment. The location and arrangement of the railroad is shown in Figure 3.9-1.

ACCESS ROADS

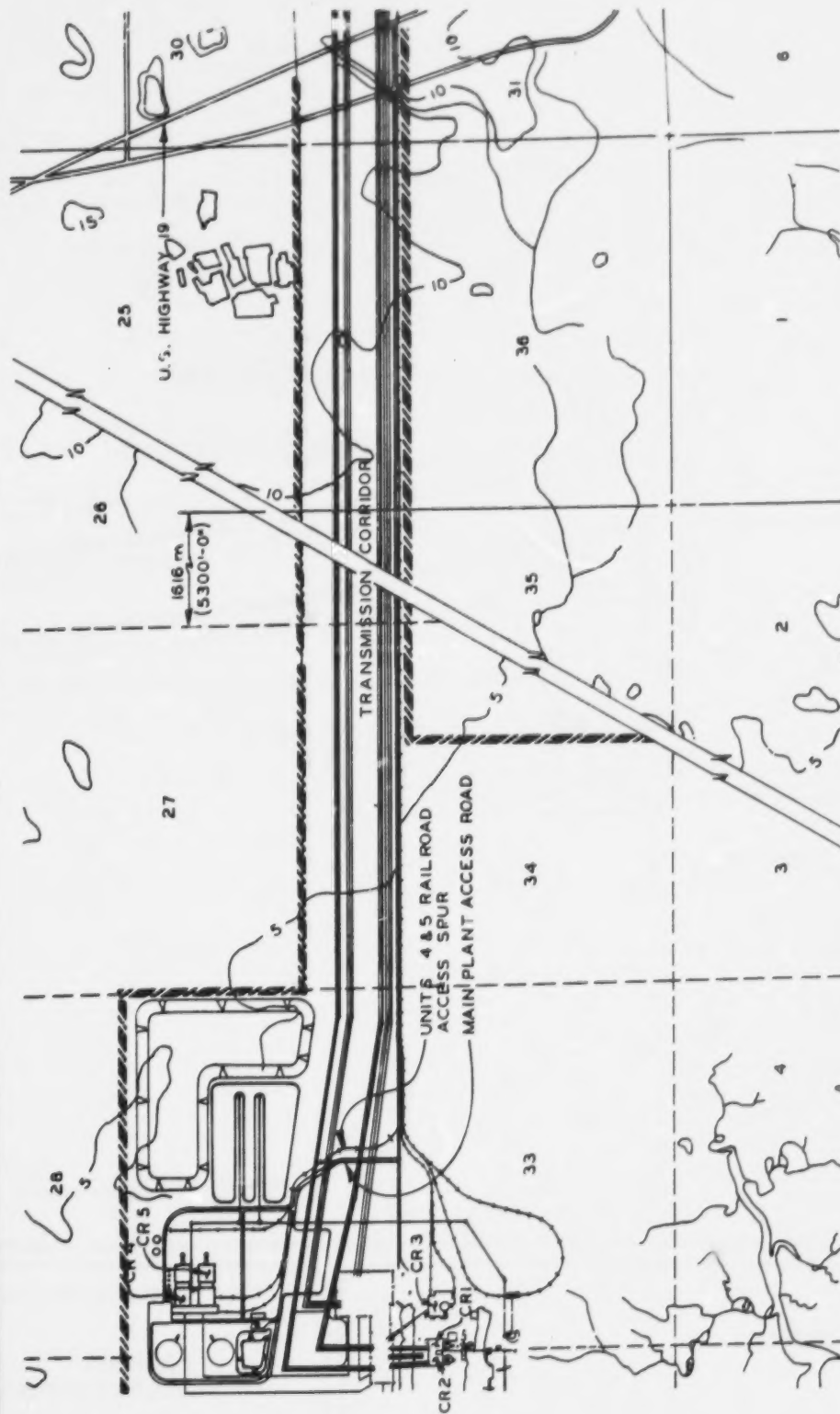
Vehicular access into the Units 4 and 5 complex will be provided from an intersection at Highway 19-98. An existing road will provide access into the area south of the existing transmission lines as shown in Figure 3.9-1. From this existing road, an access road will be provided into the Units 4 and 5.

PARKING LOTS

Parking space for vehicles will be provided south of Units 4 and 5 complex in the vicinity of the transmission lines. Approximately 6 hectares (14 acres) of parking space will be required during construction of the plants. Additional permanent parking of about 0.5 hectare (1 acre) will be provided adjacent to the Administration Building.

ADMINISTRATION BUILDING

Space for administrative personnel will be provided in an Administration Building located as shown in Figure 3.9-2. This building will be adjacent to the north end of the Turbine Building.



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

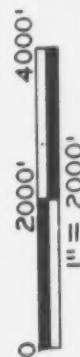


Figure 3. 9-1
ROADS AND RAILROADS

SOURCE: BLACK AND VEATCH, 1976.

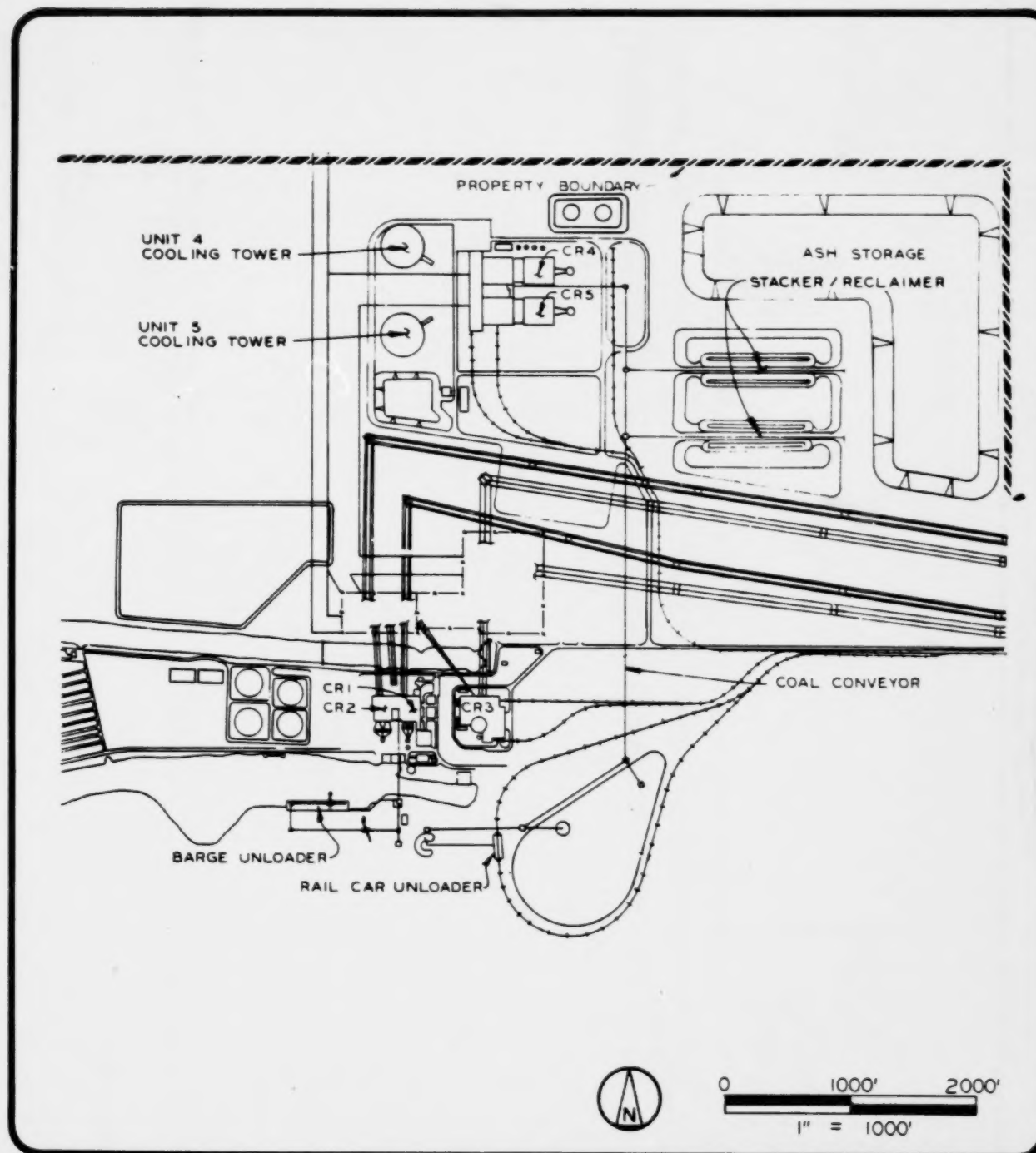


Figure 3. 9-2
ASSOCIATED FACILITIES

SOURCE: BLACK AND VEATCH, 1978.

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

MAINTENANCE BUILDING

Space for maintenance of plant equipment will be provided in a Maintenance Building. This building will be located east of the Administration Building and north of the Turbine Building as shown in Figure 3.9-2.

3.9.2 ADJACENT LAND USE

The land adjacent to the north and east property boundaries currently is undeveloped pasture land. The land west of the Units 4 and 5 plant complex is Florida Power Corporation property and will remain undeveloped.

South of the Units 4 and 5 plant complexes are the Units 1, 2, and 3 sites. The property adjacent to the south property currently is undeveloped.

3.9.3 VISIBILITY

The relatively flat topography in the area surrounding the plant site and the wooded areas adjacent to Highway 19-98 reduce public view of the plant from the east. From the Gulf of Mexico to the west, the tops of the Generation Building, cooling towers, and stacks will be visible.

3.10

ONSITE DRAINAGE AND EROSION CONTROL

3.10.1 RUNOFF COLLECTION DITCH SYSTEM

The runoff collection ditch system is designed to provide drainage for rainfall runoff from the general developed areas of the site. The runoff collection ditch system is capable of confining a quantity of water equivalent to a 10-year, 24-hour storm. The ditch system will be installed as soon as construction activities begin on the site to ensure no point source discharges to surface waters. Initially, the system will serve as the final erosion control and sedimentation basin for construction runoff. After construction is completed, the ditch will serve as a retention/exfiltration basin for runoff from surfaces in the general plant area.

The runoff collection ditch system canal layout is shown in Figure 3.10-1. A typical cross-section of the canal is shown in Figure 3.10-2. The canal bottom will be located at or near estimated high groundwater levels. Side slopes will be built up above existing grade. Channel side slopes will range from 1:3 to 1:10, approximately. Side slopes will be seeded or sodded to control erosion.

The canal will discharge into the cooling tower blowdown discharge canal. A flow control structure (NPDES 013) with an overflow spillway as shown in Figure 3.10-3 will be provided so that control of drainage will be possible in the event that high turbidity, oil spills, or other type of water quality degradation occurs; consequently, the runoff ditch collection system will function primarily as a holding and exfiltration pond. The system will be designed to retain the volume of runoff resulting from the 10-year, 24-hour rainfall event under high water table conditions.

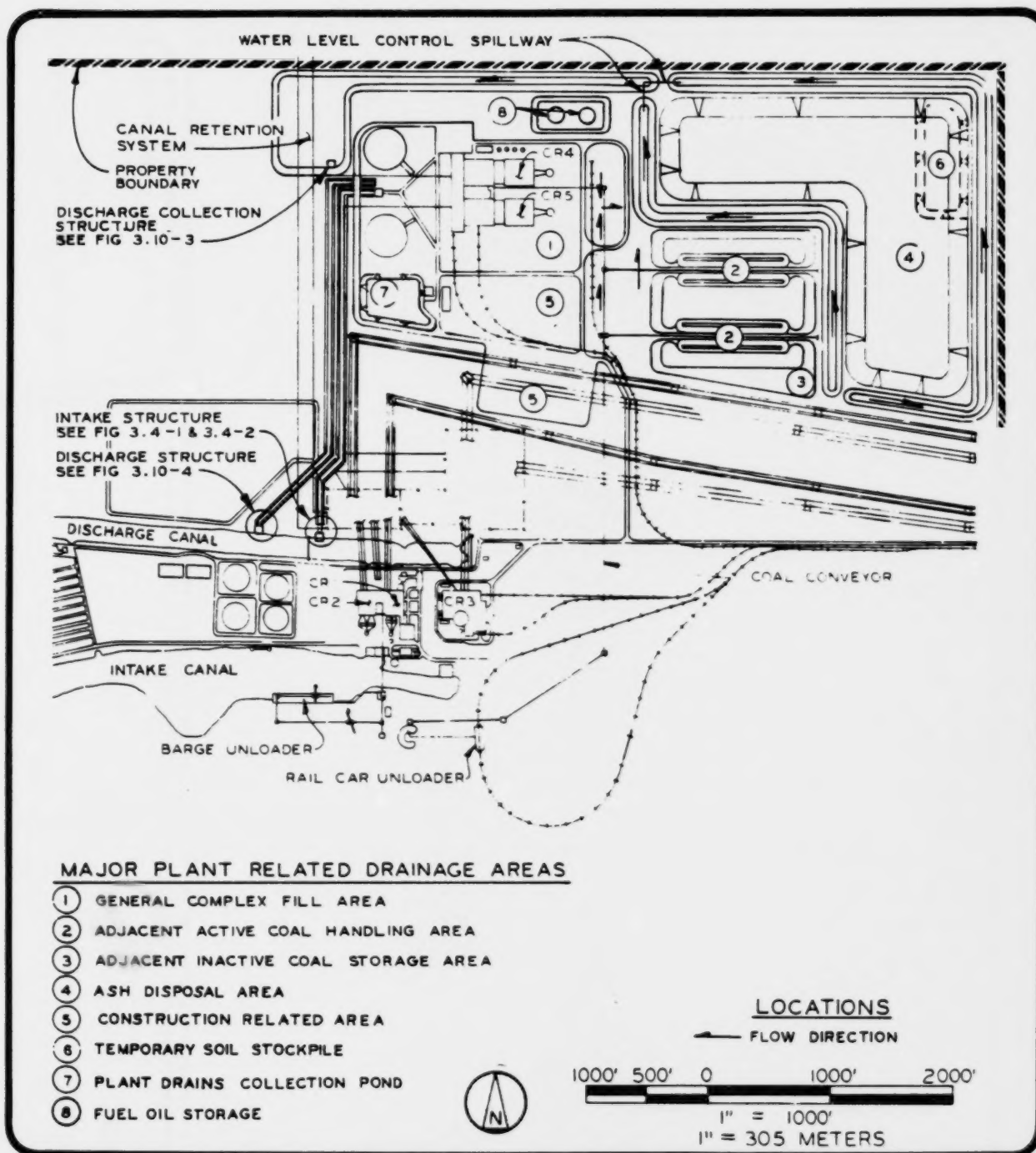


Figure 3.10-1

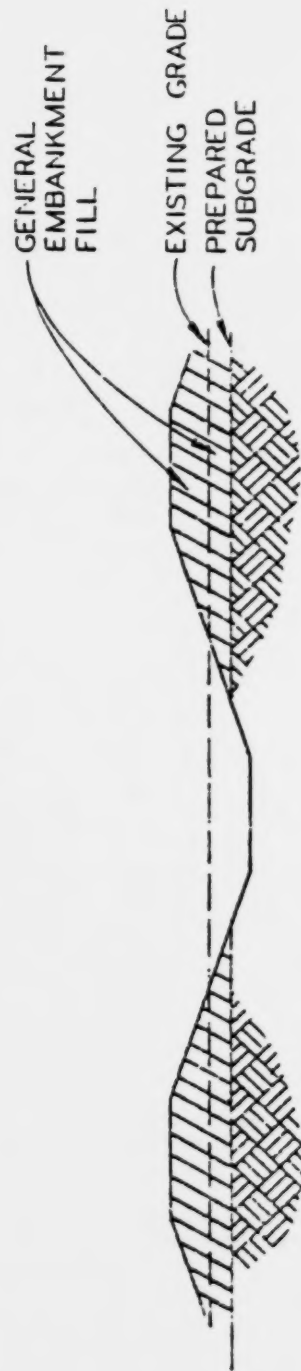
ON-SITE DRAINAGE SYSTEM

SOURCE: Black and Veatch, 1980

FLORIDA POWER CORPORATION

**PROPOSED
CRYSTAL RIVER UNITS 4 & 5**

CITRUS COUNTY, FLORIDA



TYPICAL SECTION
COLLECTION CANAL

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 3.10-2
GRADING AND DRAINAGE

SOURCE: BLACK AND VEATCH, 1976

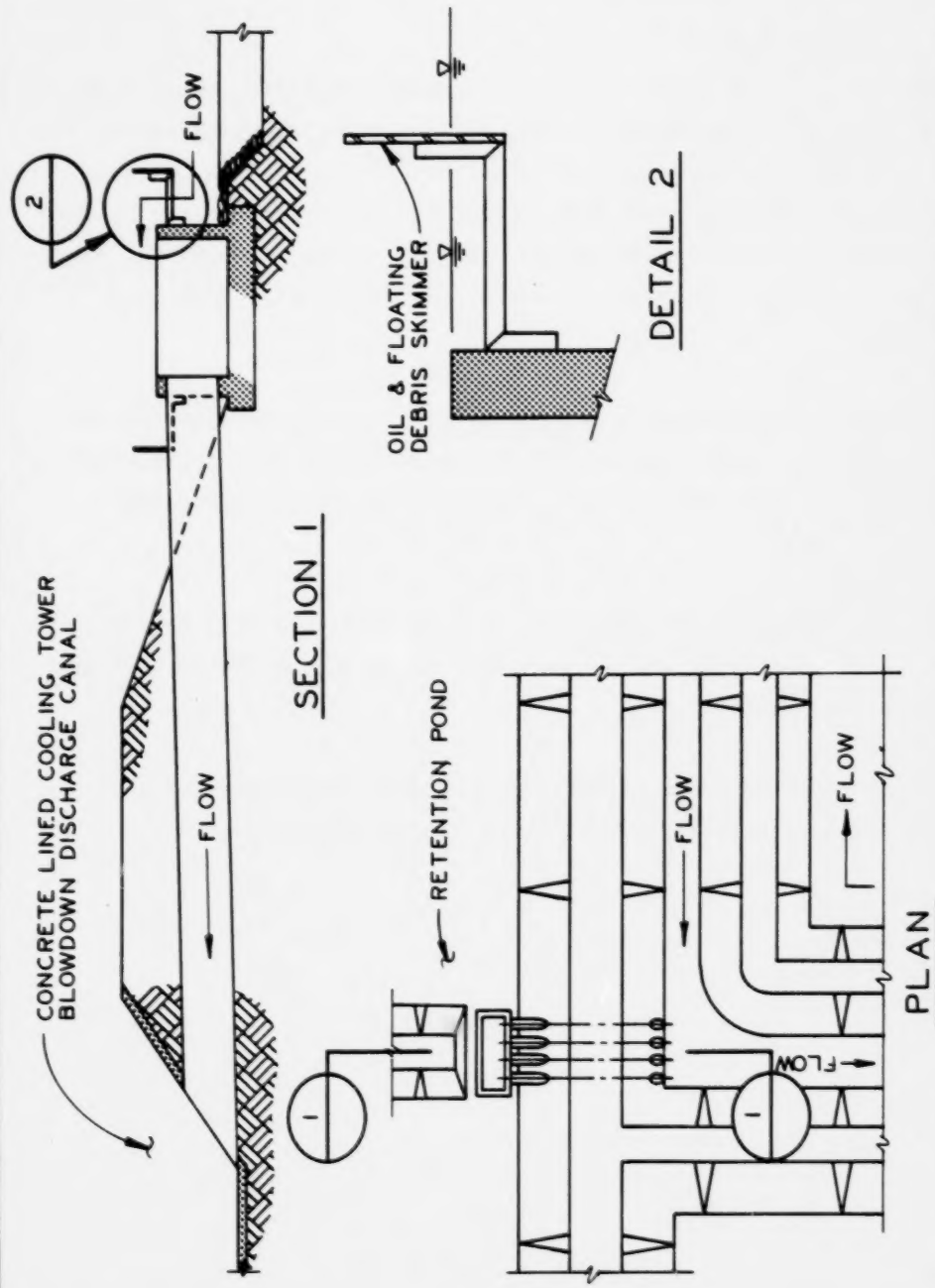


Figure 3. 10-3
DISCHARGE COLLECTION STRUCTURE

SOURCE: BLACK AND VEATCH, 1976.

FLORIDA POWER CORPORATION
PROPOSED
CRYSTAL RIVER UNITS 4 & 5
CITRUS COUNTY, FLORIDA

The runoff collection ditch system will receive rainfall runoff from the material storage piles (NPDES 011 and 012) only for rainfall runoff in excess of a quantity of water equivalent to a 10-year, 24-hour storm. Yard drainage from generation and related facility areas is conveyed to the collection canal by subgrade catch basins, piping, and ditch, dike, and culvert systems. Manholes will be provided in areas with long piping runs.

Road and railroad embankments will be sloped to drain into the ditches which will collect and transport the drainage to the collection canal. Intermediate culverts will convey drainage flow through embankment fills.

Rainfall stored within the diked oil storage tank area will be discharged to the perimeter collection canal after it has flowed through an oil-water separator.

The cooling tower blowdown discharge canal will discharge into the existing discharge canal for Units 1, 2, and 3 (Figure 3.10-4).

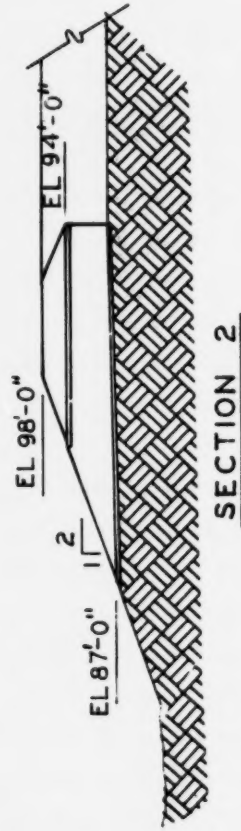
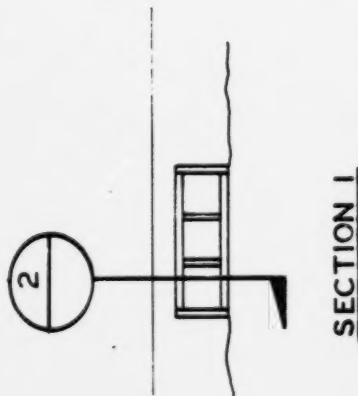
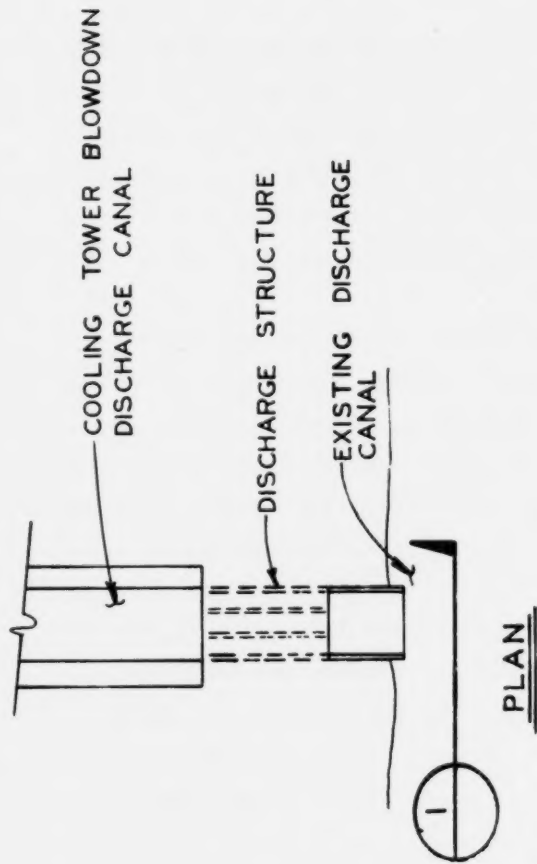


Figure 3. 10-4
DISCHARGE CANAL-DISCHARGE STRUCTURE

SOURCE: BLACK AND VEATCH, 1976.

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

3.10.2 CONSTRUCTION RUNOFF AND EROSION CONTROL

The perimeter runoff collection ditch system will be constructed as soon as site work is initiated. A temporary drainage system will be provided and maintained in the vicinity of the generating complex and laydown areas. This system will be designed to minimize effects of construction runoff and siltation by controlled collection, retention, and overflow until permanent drainage facilities are completed and functional.

Seeding of cleared lands will be required once excavation, trenching, backfill, embankments, rough grading, surfacing, and paving are completed in the vicinity of the seeding. Final acceptance of the project by the company shall include a good stand of healthy grass on all areas seeded. Specifications for types of fertilizer, seed, mulch, seed bed preparation, and topsoil are provided. Mulch will be applied at a rate of 2 tons per acre. A minimum of 6 inches of topsoil will be provided on seeded areas. Approximately 1,000 pounds per acre of fertilizer and 60 pounds per acre of seed will be applied. Planted seed will be compacted, watered, and otherwise maintained to obtain a satisfactory growth. Eroded areas will be refilled prior to final acceptance of work. Treated sewage effluent will be used to water seeded areas, when possible.

CHAPTER 4

TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
4.0	<u>SITE PREPARATION AND PLANT AND ASSOCIATED FACILITIES CONSTRUCTION/RESULTING ENVIRONMENTAL EFFECTS</u>	4-1
4.1	SITE PREPARATION AND PLANT CONSTRUCTION	4-1
	4.1.1 Construction Areas and Activities	4-1
	4.1.2 Construction Work Force and Schedule	4-3
	4.1.3 Sources of Possible Environmental Impact	4-6
	4.1.4 Mitigating Measures	4-12
4.2	UNAVOIDABLE ENVIRONMENTAL IMPACT	4-14
	4.2.1 Air Quality	4-14
	4.2.2 Water Quality	4-15
	4.2.3 Solid Wastes	4-16
	4.2.4 Noise	4-17
	4.2.5 Transportation	4-20
4.3	IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES	4-21
	4.3.1 Commitments of Materials and Energy	4-21
	4.3.2 Commitments of Land and Biota	4-22
	4.3.3 Other Impacts on Biota	4-27
	4.3.4 Impacts on Sensitive Areas	4-29

CHAPTER 4

LIST OF TABLES

<u>Table</u>		<u>Page</u>
4.1-1	Construction Manpower Requirements, Units 4 and 5, (Personnel Employed) Based on 18-Month Separation in Commercial Operating Dates	4-4
4.1-2	General Noncontrolled Noise from Construction	4-8
4.2-1	Qualitative Relationship Between NPL and Annoyance from Construction Activities	4-19
4.3-1	Plant Communities Areas to be Impacted by Construction	4-23

CHAPTER 4

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
4.1-1	Construction Schedule, Crystal River Units 4 and 5	4-5

4.0 SITE PREPARATION AND PLANT AND ASSOCIATED FACILITIES
CONSTRUCTION/RESULTING ENVIRONMENTAL EFFECTS

4.1 SITE PREPARATION AND PLANT CONSTRUCTION

4.1.1 CONSTRUCTION AREAS AND ACTIVITIES

Construction of the proposed units will begin by clearing 26 hectares (65 acres) within the proposed plant area. A minimum of approximately 5.54 hectares (13.7 acres) of this area will be required to prepare foundations for the facility and cooling towers. The remaining land area will include construction parking, field offices, and laydown areas. A total of 135 hectares (333 acres) will be cleared for construction of Units 4 and 5, including the permanent ash storage area which will be used for laydown area during construction.

Grading and filling will elevate the plant area from approximately 28 meters (94 feet--plant datum) to approximately 30 meters (99 feet) which is approximately 3.4 meters (11 feet) above mean low water. Cooling towers, the turbine generator building, the air pre-heater building, electrostatic precipitators, stacks and coal crusher building will be the primary structures requiring subsurface grouting and surface fill. Approximately 0.6 meters (2.0 feet) of overburden (organic, muck or silt material only) will be removed in the vicinity of these structures to expose load-bearing formations.

The fill for supporting plant structures will necessitate approximately 140,000 cubic meters (180,000 cubic yards) of material. The fill, which will be either coarse and/or Brookville limestone, will be obtained primarily from local sources. For general fill, overburden from the site and nearby limestone and dolomite mines will be used.

Support of plant foundation will be accomplished with drilled piers. Drilled piers, constructed of reinforced concrete and approximately 48 inches in diameter, are placed to bedrock depth. Approximately 200 drilled piers will be placed through the Inglis formation to a depth of approximately 15 meters (50 feet).

Heavy equipment such as the turbine generator, steam generator, and materials such as structural steel will be transported to the construction area by rail. Trucks will deliver the remaining equipment and supplies. During construction activities, approximately 45 to 50 trucks will arrive daily. These trucks will haul concrete, lumber, fuel, and other supplies.

Water will be needed for hydrostatic testing of tanks, cleaning, drinking, sanitary facilities, soil compaction, and fugitive emissions control. The water supply for these purposes will be obtained from the existing freshwater wells for Crystal River Units 1, 2, and 3 and/or a new well field. It is estimated that less than 150,000 liters per day (40,000 gallons per day) will be required for these purposes. Electrical power needed for construction activities will be obtained from the existing distribution lines in the area.

A small amount of dredging will be necessary for the construction of a saltwater makeup intake structure and a discharge structure. The amount of material dredged from the discharge canal will be less than 160 cubic yards. All dredging will take place during a period of one month.

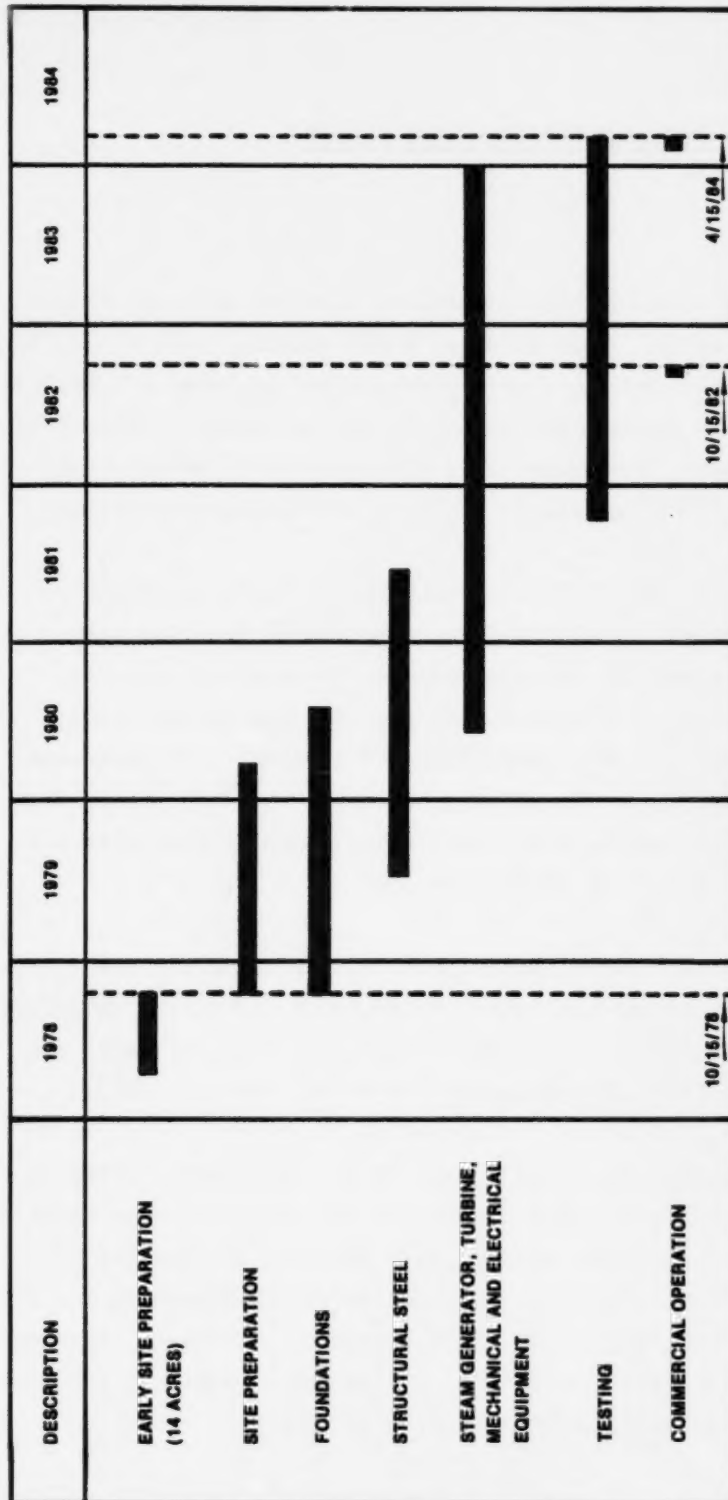
4.1.2 CONSTRUCTION WORK FORCE AND SCHEDULE

Table 4.1-1 and Figure 4.1-1 present manpower requirements and the construction schedule. The construction period for each unit will be 48 months.

Table 4.1-1 Construction Manpower Requirements, Units 4 and 5,
(Personnel Employed) Based on 18-Month Separation in
Commercial Operating Dates

	1978	1979	1980	1981	1982	1983	1984
January	---	150	380	1,000	1,275	840	150
April	10	175	425	1,040	1,050	760	80
July	25	250	740	1,080	920	710	50
October	75	340	940	1,150	860	300	25

Source: Florida Power Corporation, 1978.



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 4.1-1
CONSTRUCTION SCHEDULE, CRYSTAL RIVER UNITS 4 AND 5

SOURCE: FLORIDA POWER CORPORATION, 1978

4.1.3 SOURCES OF POSSIBLE ENVIRONMENTAL IMPACT

AIR EMISSIONS

Various construction activities associated with the site development, including land clearing, open burning, heavy machinery operation, truck traffic and road construction, will generate air pollutants. Because of the nature of these operations, emissions are extremely difficult to quantify accurately. Therefore, this discussion will address only the qualitative air pollution aspects of these construction activities.

The most significant air pollutant generated by heavy construction operations will be particulate matter, also termed fugitive dust. The quantities of dust emitted are dependent on a number of factors, including the frequency of operations, specific operations being conducted, weather, and soil conditions. The majority of generated dusts, however, are typically of large particle size and settle near the source. In addition, some of the operations, such as land clearing, are intermittent and usually of short duration.

Some of these dusts, however, will remain suspended in the atmosphere. Suspended dust emissions from heavy construction operations have been estimated to be 3.0 metric tons per hectare (1.2 tons per acre) per month of activity (U.S. Environmental Protection Agency, 1975).

Open burning, also a significant source of air pollutants during construction, will emit quantities of particulate matter, carbon monoxide, hydrocarbons, sulfur oxides, and nitrogen oxides. The burning of land-clearing debris, primarily trees and scrub underbrush in the area, will be conducted for periods of short duration. Pollutant emissions depend on the moisture of the debris, the amount of material per acre, and the way the refuse is arranged (piles or rows).

The following emission factors for open burning of forest residues (U.S. EPA, 1975) have been estimated: particulate, 7.6 kilograms per metric ton (17 pounds per ton) refuse burned; carbon monoxide, 40 kilograms per metric ton (90 pounds per ton); and hydrocarbons, 11 kilograms per metric ton (24 pounds per ton).

Exhausts of heavy machine and truck traffic will be a minor source of air pollutants, mainly carbon monoxide, particulate matter, nitrogen oxides, hydrocarbons, and sulfur oxides. These exhaust emissions will be of relatively small quantities because of the amount of construction traffic expected.

NOISE SOURCES

During the site development and construction phase of the project, noise will be created by both traffic and equipment. The transient nature of these sources precludes rigorous determination of noise sources. Nevertheless, an estimate of worst-case noise can be made for an analysis of impacts.

Studies have been conducted to determine noise levels generated by the equipment used during various phases of construction (U.S. EPA, 1971). The 15-meter (50-foot) levels for general noncontrolled noise from construction equipment are presented in Table 4.1-2. A good approximation of a worst-case noise emission can be determined by selecting four sources which are assumed to operate simultaneously at a single location. The sound pressure levels of these four pieces of equipment can be combined into a single source by adding energy levels from each source. It is estimated that two sources at 80 dBA, one at 85 dBA, and one at 91 dBA would be operating simultaneously for the worst-case construction impact. The impacts of these sources are discussed in Section 4.2.4.

Table 4.1-2 General Noncontrolled Noise From Construction Equipment

Equipment	Noise Levels (dBA)*
Earthmoving	
Front Loader	79
Backhoes	85
Dozers	80
Tractors	80
Scrapers	88
Graders	85
Trucks	91
Paver	89
Materials Handling	85
Concrete Mixer	82
Concrete Pump	83
Crane	83
Derrick	88
Stationary	
Pumps	76
Generators	78
Compressors	81
Impact	
Pile Drivers	101
Jack Hammers	88
Pneumatic Tools	86
Other	
Saws	78
Vibrator	76

* All noise levels in dBA measured at a distance of 15 meters (50 feet) from the equipment.

Source: U.S. Environmental Protection Agency, 1971.

WATER QUALITY

The proposed plant site will require clearing, grading, and leveling which will be confined to those areas required for the construction of permanent plant facilities and temporary support facilities. The soil type is Broward, a thin surface layer of coastal sand with frequent limestone outcroppings. The soil is highly permeable with a minimum percolation rate of 50 centimeters per hour (20 inches per hour). Existing surface drainage goes primarily into the groundwater table, which is at a maximum depth of 60 centimeters (24 inches) below the surface. The groundwater table depth also corresponds to the mean low water (mlw) elevation due to the nearness of the plant site to the coast.

The summer rainy season, which is from June through September, is characterized by high intensity, localized thunderstorms. These thunderstorms have an average return frequency of two days, with rainfall intensities ranging from .064 millimeters to .76 millimeters per hour (0.25 to 3.0 inches per hour). The winter wet season, which occurs from October through May, is characterized by frontal systems of less intensity than the summer thundershowers.

Runoff from the plant site is currently minimal because of the excellent percolation of the Broward soil and the nearness of the watertable to the surface. However, prior to and during the construction phase, the plant area is to be filled to an elevation of approximately 3.4 meters (11 feet) above mlw. This filling will decrease the percolation rate and increase the possibility of runoff from the site. Runoff will be greater during the summer wet season and will be accompanied by an increased suspended sediment load (refer to Mitigating Measures, Section 4.1.4). All runoff will be retained on site.

Sanitary wastes can be a potential source of water contamination if they are not disposed of pursuant to Florida regulations. Sanitary wastes

will be handled by portable chemical facilities and a sanitary sewage system both in accordance with Florida State Regulations. The latter will become available in the early stages of Units 4 and 5 construction, and will discharge to a percolation pond. Other chemical and petroleum wastes will be disposed of in accordance with state and federal regulations.

SOLID WASTES

Solid wastes other than land-clearing debris will include scrap lumber, scrap metal, crating and cardboard from equipment containers, paper and plastic from packaging, field-office wastes, and other trash. An estimated 1,800 cubic meters (2,400 cubic yards) of such wastes will be generated from construction.

TRANSPORTATION

During the construction phase, additional traffic in the site area will be generated by the construction work force and deliveries of equipment and supplies. The construction work force will use private vehicles, automobiles, pick-up trucks, etc., for transportation to and from the site. In 1982, when the construction work force is at a peak, it is estimated that approximately 2,000 trips per day will be generated by the construction employees. Also, during the peak construction, approximately 50 delivery vehicles are expected to access the site daily. U.S. Highway 19 will be the major roadway receiving the additional traffic generated by the construction activities. Except for some minor slowdowns in flows due to turning at the site access road, the impact on the highway traffic is expected to be minimal, based on highway usage projections and capacities developed by the Withlacoochee Regional Planning Council.

During construction, some of the heavy equipment and materials will be transported to the site by rail. The exact number and schedule for these trains is unknown at the present time; however, traffic delays on

FPCR4/5-TSD4.1/R4-1.8
3/25/80

U.S. Highway 19 due to these train crossings will be less than two minutes per delivery arrival and departure.

4.1.4 MITIGATING MEASURES

AMBIENT AIR QUALITY

Modern methods of dust control and dust emission prevention will mitigate the effects of construction in the vicinity of the proposed site. Air quality control rules of the State of Florida for fugitive dust emissions and open burning will also be met (Florida Department of Environmental Regulation, Ch. 17-2.04 (3) F.A.C.; and Florida Division of Forestry, Ch. 51-2 F.A.C.).

To achieve full compliance with these regulations, the following mitigative control will be implemented during construction:

1. All reasonable precautions will be taken to prevent fugitive dust emissions. Such precautions will include using, where practicable, asphalt or oil, water or dust-suppression chemicals for the control of dust from grading and clearing operations and on dirt roads.
2. Open burning of land clearing debris will comply with these conditions:
 - a. Burning will be performed between 9:00 a.m. (Eastern Standard Time) and one hour before sunset; at other times, a forced-draft system will be used.
 - b. The burning location will be at least 45 meters (50 yards) from the nearest occupied building or public highway.
 - c. Piles will be no larger than can be burned within the designated time.
 - d. Moisture content and composition will be favorable for good burning.
 - e. Smoke emissions will not exceed 40 percent opacity or Number 2 on the Ringelmann chart, except during startup.

WATER QUALITY

To eliminate construction runoff and siltation in nearby surface waters, detention ponds will be constructed as necessary. All construction areas, as they are cleared, will be diked. Drainage areas will be established adjacent to dikes in order to allow for evaporation and percolation of any runoff collected. There will be no point source discharges to waters of the United States during construction. Surface water runoff will also be utilized for dust suppression. Sanitary waste disposed of on site will receive secondary treatment and will be discharged to an evaporation/percolation pond.

SOLID WASTES

Waste materials, such as scrap lumber and metal, will be recycled. Periodically, these materials will be stockpiled in areas where salvage operations can transport them off site. Other solid wastes will be landfilled in approved areas near the existing units.

4.2

UNAVOIDABLE ENVIRONMENTAL IMPACTS

4.2.1 AIR QUALITY

The heavy construction activities will have a short-term impact in the immediate vicinity, primarily on suspended particulate matter levels. These levels are expected to increase during construction, both on site and in the vicinity of the proposed facility. Ambient air quality standards for particulate matter are not expected to be exceeded beyond a few hundred feet from the operations (Kosky, 1975). Permanent or long-term impacts related to heavy construction activities are not expected.

Short-term impacts will also result from open burning. Since these operations will be conducted during periods of excellent dispersion and will be of short duration, no permanent or long-term impacts are expected.

The isolation of the site and the prevailing meteorology will substantially reduce air quality impact. In addition, the methods that will be used for fugitive emissions control are estimated to reduce emissions by 80 to 50 percent (Dunbar, 1975; Kosky, 1975).

Air pollution impacts from increased traffic will be associated primarily with the new access road. Since nearby U.S. Highway 19-98 is a major four-lane highway, facility-related traffic will not significantly influence carbon monoxide levels.

4.2.2 WATER QUALITY

During construction, turbidity and sediment loading to the nearby marsh areas from runoff will be mitigated by an erosion and sediment control plan. The erosion and sediment control plan will include the use of state-of-the-art erosion techniques (berms, mulch, sodding, and detention/infiltration ponds) during construction, to mitigate adverse effects on the adjacent surface waters. Construction of the stormwater retention areas at the plant site will abate the runoff sediment load impact on the marsh. A small amount of dredging activity in the discharge canal will increase the turbidity in the canal and adjacent areas. This impact will be extremely short-term, i.e., no longer than one month in duration.

The changes in surface water chemistry or quality due to construction activities will be minor. There probably will be less organic material in the waters because of the removal of the vegetation and the filtration effects of the surface fill mat. The pH of the water to the south and west of the site may be increased slightly (i.e., become more basic) because of the presence of the limestone fill material which has a much smaller pebble size relative to the underlying limestone rockbed. Also, the mineralization of the water may increase slightly because the organic overburden has been removed, and the small, pebble-sized fill material allows the water to be in more direct contact with minerals (i.e., calcium and magnesium ions). These possible water quality changes should not cause a violation of any promulgated water quality standards. Major hydraulic or dragline dredging operations and the use of explosives are not expected during the construction period. The leachate monitoring program described in Section 6.2.3 of Chapter 6 includes a year-long study of on-site groundwater quality which quantifies relevant parameters during construction. Major hydraulic or dragline dredging operations and the use of explosives will not be necessary during the construction period.

4.2.3 SOLID WASTES

The impacts of solid wastes will be limited to land utilization for those materials that cannot be recycled. Since an approved area near the existing units will be used, impacts are minimal.

4.2.4 NOISE

As discussed in Section 4.1.3, maximum noise emissions were estimated under the assumption that four major sources would be in operation at any time. The four sources were assumed to produce sound levels of 91 dBA, 85 dBA, 80 dBA, and 80 dBA at 15 meters (50 feet).

Since the precise location of each source with respect to others at any given time cannot be pinpointed, it is difficult to predict sound levels at receptors near the plant. At more distant locations, analyses were performed by combining the effects of each and every source and creating a single larger source. This combined source exhibits a sound level of 93 dBA at 15 meters (50 feet).

It was assumed that a 6 dBA drop per doubling of distance between the source and receptor would be realized. The following results from this worst-case analysis were obtained:

<u>Distance Between Source and Receptor (km)</u>	<u>Sound Level (dBA)</u>
.5	63
1.0	57
5.0	43

A further decrease due to vegetation between the source and receptors can be expected. For the purposes of noise analyses, a 5 dBA reduction in noise per 30 meters (98 feet) of thick plantings and a 2 dBA reduction in noise per 30 meters (98 feet) of sparse plantings are allowable (Bolt, Beranek and Newman, 1973). A maximum of 10 dBA may be deducted due to attenuation by vegetation, and this figure may be applied to the values above.

The distance to the nearest sensitive receptor from the center of the proposed construction activities is 8 kilometers (5 miles). At this distance, the maximum sound level will be 39 dBA due to geometric attenuation alone. With the additional effect due to the existence of

vegetation, the sound level will be 29 dBA, which will be indiscernible.

Judgments regarding the annoyance or average noise potential are made by evaluating the description known as the Noise Pollution Level (NPL). NPL is defined as the sum of the A-weighted average sound level and 2.56 times the standard deviation of that sound level. A qualitative evaluation of NPL with respect to annoyance is presented in Table 4.2-1.

Assuming a standard deviation in sound level of 5 dBA, the NPL expected at the nearest sensitive receptor is 42 dB. This level clearly is acceptable according to the criteria listed in Table 4.2-1. A receptor would have to be located within 0.2 kilometer (0.1 mile) of the construction site before the NPL would be "normally unacceptable."

The foregoing analysis excludes a consideration for barriers such as those provided by existing structures.

Noise resulting from construction activities may disturb some wildlife species and cause them to avoid certain areas of the site. This disturbance may interrupt feeding and reproductive activities within 0.5 kilometer (0.3 mile) of the construction site. The significance of this impact is considered low because of the limited degree of disturbance, the ability of the animals to adapt, and the commonness of the majority of the species. These impacts are considered reversible.

Table 4.2-1 Qualitative Relationship Between NPL and Annoyance from Construction Activities

<u>Clearly Acceptable:</u> The noise exposure is such that both the indoor and outdoor environments are pleasant.	NPL less than 62 dB
<u>Normally Acceptable:</u> The noise exposure is great enough to be of some concern but common building constructions will make the indoor environment acceptable, even for sleeping quarters, and the outdoor environment will be reasonably pleasant for recreation and play.	NPL between 62 and 74 dB
<u>Normally Unacceptable:</u> The noise exposure is significantly more severe so that unusual and costly building constructions are necessary to ensure some tranquility indoors, and barriers must be erected between the site and prominent noise sources to make the outdoor environment tolerable.	NPL between 74 and 88 dB
<u>Clearly Unacceptable:</u> The noise exposure at the site is so severe that the construction costs to make the indoor environment acceptable would be prohibitive and the outdoor environment would still be intolerable.	NPL greater than 88 dB

Source: U.S. Environmental Protection Agency, 1971.

4.2.5 TRANSPORTATION

Movement of construction traffic and heavy machinery will result in unavoidable soil compaction. Moehring (1970) has documented three major effects of heavy logging machinery on soils: compaction, puddling, and soil displacement. Resulting increased surface runoff may favor wetland vegetation in low-lying areas. However, Perry (1964) and Hatchell and Roberts (1969) have postulated an extended recovery time for such soils with a resulting decrease in natural productivity and in the rate of succession. Since most of the areas temporarily affected are in currently disturbed transmission corridors, the significance of the impact is considered low.

An increase in "road-kills" of species such as rabbits, turtles, and armadillos will likely result from the increased traffic to and from the site. The significance and the magnitude of this impact are considered low in terms of the numbers of animals which will be killed relative to the natural population levels. In addition, since construction activities are primarily confined to daylight hours, the probability of "road-kills" is reduced.

U.S. Highway 19-98 will be the major road impacted by construction activities. Based upon its current use as a major transportation corridor, the impact of increased traffic to and from the site will be minimal.

4.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

4.3.1 COMMITMENTS OF MATERIALS AND ENERGY

The quantities of construction materials needed for the proposed plants have not been computed at this time. Concrete, reinforcing and structural steel, and fill material are the main resources which will be committed. The majority of these materials will not be recoverable and will constitute an irreversible commitment. Some of these materials, however, will be suitable for recycling.

Many of the materials used in the construction process, such as building forms, temporary structures, and unused materials, will be sold or re-used following the construction period.

Irretrievable energy commitments will include electrical energy, and diesel and other fuel oils.

4.3.2 COMMITMENTS OF LAND AND BIOTA

About 136 hectares (333 acres) of land will be required for the plant and its associated facilities. The loss of plant communities will be experienced in the approximate amounts listed in Table 4.3-1.

Of this total acreage, the rail spur will need 0.4 hectares (1.0 acre) of hydric hammock and 1.2 hectares (3.0 acres) of ruderal land. The regional significance of these impacts is low because of the small land area or percentage of habitat involved.

The land clearing will cause a loss of timber volume that is estimated to be about 4.6 cubic meters per hectare (163 cubic feet per acre) of pulpwood; 0.1 cubic meter per hectare (1.4 cubic feet per acre) of slash pine; and 250,000 to 375,000 board feet (2,000 to 4,000 board feet per acre) of hardwoods and conifers. This loss is not significant because of the low commercial value due to the small tree size, and the high proportion of rough trees (non-commercial species and unacceptable trees of commercial species). The agricultural value of the land is low.

The loss of natural communities is of low significance because of the relatively early successional status and disturbed state of most of the land to be cleared (see Section 2.7.2).

However, individuals of the rare plant species coontie (Section 2.7.3) have been observed on the site and will be destroyed. The magnitude and significance of this impact is considered low since the species is relatively abundant in the region. Nevertheless, impacts on such species are cumulative in that they contribute to the general reduction of populations from other human activities.

The projected ash storage area is not sufficient to contain all of the ash produced during the plant life. Florida Power intends to actively

Table 4.3-1 Plant Communities Areas to be Impacted by Construction

Habitat	Hectares	Percent of Total Habitat Type Within the 8-Kilometer (5-Mile) Radius
Coastal hydric hammock	2.4 (6 acres)	0.2
Hydric hammock	22 (55 acres)	52
Mesic hammock	24 (62 acres)	2.3
Slash pine flatwoods	60 (148 acres)	2.6
Evergreen oak scrub	4.5 (11 acres)	79
Freshwater marsh	10 (25 acres)	3.6
Ruderal land	10 (26 acres)	1

Source: Environmental Science and Engineering, Inc., 1977.

market the ash. However, if all the ash cannot be sold, then up to approximately 60 hectares (150 acres) of Florida Power's remaining existing property will be dedicated to ash storage or a suitable ash storage area will be found off site.

WILDLIFE HABITAT

An important impact of the development of the property will be the loss of habitat for wildlife.

Construction activities will ultimately affect about 120 hectares (300 acres) of wildlife habitat. The construction of roads, railroad spurs, and other construction activities may also cause additional destruction of about 13 hectares (33 acres) of habitat. Most wildlife will leave the immediate vicinity of construction as human activities increase. The clearing process will destroy resident "non-important" wildlife populations, especially small mammals and various herpetofauna. Some of the more mobile species of wildlife (e.g., opossum, raccoon, and deer) will leave the area. Those wildlife that are displaced will either move into adjoining, less suitable habitats, or they will migrate to an area similar to that from which they have been displaced. Since most lands are at or near carrying capacity for wildlife, the net result of the removal of wildlife habitat, given a period of time for population stabilization, will be to reduce wildlife population in the region in proportion to the reduced habitat area.

The major wildlife habitats to be impacted are the on-site pine flat-woods, evergreen oak scrub, freshwater marsh communities, and mesic and hydric hammocks. The clearing operation will destroy some habitat for a number of wildlife species.

The major impacts on rare and endangered animals will involve gopher tortoise, indigo snake, Florida mouse, and possibly the scrub jay. The

on-site habitat of the gopher tortoise, Florida mouse, and scrub jay will be eliminated by the clearing operation for plant construction. Since the area of suitable habitat for the gopher tortoise is very small, the extent of this impact is low. Since the scrub jay was not observed on-site, impacts will probably be limited to habitat loss. The overall impact on rare and endangered animals should not be significant because of the relatively small area to be affected.

Present information on the life habits, home range, and ecology of the indigo snake is very limited. These information gaps make it particularly difficult to assess impacts of various activities on individual indigo snakes as well as various populations of this species (Campbell, 1978). However, it does appear that for a species with a relatively large geographic distribution and with a wide range of habitats, the loss of 300 acres of habitat would not be considered critical to its survival. The construction of the power plant would result in the loss of some prime habitat, but would not result in significant population losses for this species. Because the indigo snake can utilize a variety of habitats (Kochman, 1976) and there are areas of suitable habitat within the vicinity, the plant construction will not significantly reduce areas of habitation for this species. Mitigating measures include availability of suitable habitat on adjoining lands and the preservation of approximately 150 acres of hydric hammock forest on the Florida Power plant site.

In general, the significance of wildlife habitat loss is not great because of the commonness of most species involved. All populations in the area are currently self-sustaining. The magnitude of the impact of these activities within the site is great because the changes will render most of the site unusable by wildlife; however, the areawide magnitude of these changes is not great because of the current abundance of available forest habitat in the region. These impacts are irreversible and are a long-term loss of natural wildlife resources to the site and the area.

Loss of or impact on aquatic habitats from the construction of Units 4 and 5 should be minimal. Assuming adequate control of erosion during construction, the only loss would be a few shallow temporary ponds which were completely dry at the time of the site visit (August, 1977). The plant site has been shifted to the east to avoid destruction of 112.3 hectares (277 acres) of coastal salt marsh, 13.7 hectares (34 acres) of coastal hammock, and 49.6 hectares (122 acres) of coastal hydric hammock mesic forest further west on Florida Power's property. The preservation of this habitat is a significant mitigative measure.

4.3.3 OTHER IMPACTS ON BIOTA

It is felt that the transmissivity of the aquifer is sufficiently high to preclude significant restriction of subsurface flow at the site. While there remains a low probability that grouting could alter groundwater flow sufficiently to reduce the freshwater subsidy of a small portion of the coastal hydric hammock nearest to the construction site, the use of drilled piers will significantly reduce the probability of any adverse impact to the groundwater flow. The use of drilled pier construction makes the probability of impacts to groundwater flow negligible.

Construction of the rail spur may also affect nearby plant communities through alteration of surface drainage. The magnitude of this effect will depend upon construction design, such as the number and placement of culverts, which has not been developed at this time. The magnitude and significance are low.

Because of the relatively low volume of ground water needed for sanitary waste usage and the intermittent form and short duration of usage for such construction activities as watering of roads for dust control or mixing of concrete, the impacts of water usage on biota are expected to be undetectable. Since the probability of toxic compounds leaching into groundwater during construction is very low, this is also not expected to impact biota. Construction phase potable water supply from an existing on-site well is not expected to have a significant effect on the plentiful groundwater resources that characterize the area.

Because of the large area of pine plantations adjoining the proposed plant site, the overall effect of clearing operations on site may have an impact on wildlife from surrounding areas. The major impact on off-site wildlife will be to reduce food supplies and denning sites for some of the more wide-ranging species. Habitat alterations, including loss of acreage of oak upland near large tracts of monocultured, even-aged (pine plantation) forest may eliminate or reduce the home range of various species.

Oaks adjoining upland pine sites are essential in providing food for wildlife and offer diversity in habitat in homogeneous pine plantation (Goodrum et al., 1971). It can be anticipated that predatory and foraging animals which utilize these areas will have to adjust to the diminished food supplies. This will cause either a decreased carrying capacity for ranging species (i.e., deer, bobcat, and raccoon) or a shift in feeding areas to surrounding habitats. This impact on the terrestrial ecology of the area, although difficult to estimate, is considered minimal because of the relatively small acreage to be cleared.

IMPACTS DUE TO TRANSPORTATION

The increased traffic along the access road because of the plant operation will increase "road kills" of wildlife. Because of traffic and other human activity along the road, species such as deer are less likely to cross into the median area. In addition, some wildlife will not cross this barrier because of insufficient cover. The magnitude of this impact is considered moderate for the route and low for the surrounding area. These impacts will be long-term and reversible.

4.3.4 IMPACTS ON SENSITIVE AREAS

The coastal hydric hammock should be regarded as a sensitive area because of its wetland nature, old-age trees, and natural values (Section 2.7.2). It is the only sensitive area likely to be impacted by the project. Impacts will include clearing of 2.5 hectares (6.3 acres), a loss of a protective vegetation buffer, and increased potential for exotic species introduction. Florida Power Corporation will mitigate impacts to a large extent by refraining from mowing or use of herbicides following construction and allowing maximum practical regrowth. Other impacts are probably minor in magnitude and regional significance. However, all of these impacts are cumulative and in aggregate may impact the system.

CHAPTER 5

TABLE OF CONTENTS

<u>Chapter</u>		<u>Page</u>
5.0	<u>ENVIRONMENTAL IMPACT OF PLANT OPERATION AND ASSOCIATED TRANSMISSION FACILITIES</u>	5-1
5.1	HEAT DISSIPATION SYSTEM	5-1
	5.1.1 Determination of Maximum Fog Potential	5-1
	5.1.2 Cooling Tower Drift	5-7
	5.1.3 Biological Impacts of Impingement and Entrainment	5-17
5.2	IMPACTS ON SURFACE WATERS	5-24
	5.2.1 Summary of Wastewater Disposal Systems	5-24
	5.2.2 Cooling System Blowdown	5-28
	5.2.3 Boiler Blowdown	5-33
	5.2.4 Stormwater Discharges	5-34
	5.2.5 Potential Leachate Contamination	5-36
	5.2.6 Cooling System Intake	5-37
5.3	IMPACTS ON GROUNDWATER SYSTEMS	5-39
	5.3.1 Introduction	5-39
	5.3.2 Physical Effects of Groundwater Withdrawal	5-48
	5.3.3 Biological Effects of Groundwater Withdrawal	5-54
	5.3.4 Leachate from Coal and Ash Storage	5-55
	5.3.5 Leachate Impacts at Crystal River Site	5-68
5.4	PSD ANALYSIS—AIR QUALITY	5-71
	5.4.1 Class II PSD Analysis	5-71
	5.4.2 Class I PSD Analysis	5-81
	5.4.3 Conclusions	5-83
5.5	DIRECTLY ASSOCIATED TRANSMISSION SYSTEM	5-84
5.6	DIRECTLY ASSOCIATED FACILITIES	5-85
	5.6.1 Coal Handling	5-86
	5.6.2 Bottom and Fly Ash Handling	5-87
	5.6.3 Solid Waste Disposal and Land Reclamation	5-88
	5.6.4 Noise	5-89
	5.6.5 Transportation	5-90
5.7	RESOURCES COMMITTED AND UNAVOIDABLE ENVIRONMENTAL IMPACTS	5-92
5.8	MITIGATIVE MEASURES	5-95
	5.8.1 Site Selection	5-96
	5.8.2 Arrangement on the Site	5-97
	5.8.3 Control Technology	5-98

CHAPTER 5

LIST OF TABLES

<u>Table</u>	<u>Page</u>
5.1-1 Number of Hours of Saturation Deficit $<0.4 \text{ g/m}^3$ of Dense Fog, and of Maximum Fogging Potential--Tampa, Florida, 1964, 24 Observations Per Day	5-3
5.1-2 Wind Distribution of Maximum Fogging Potential	5-4
5.1-3 Relative Wind Distribution of Maximum Fogging Potential	5-5
5.2-1 Wastewater Flow Summary	5-25
5.2-2 Summary of Cooling Tower Thermal Impacts	5-30
5.3-1 Alternative Florida Power Corporation Coal Sources	5-56
5.3-2 Percent Composition Comparison of Eastern and Western Coals	5-57
5.3-3 Heavy Metal Concentration of Fly Ash and Bottom Ash	5-58
5.3-4 Chemical Characteristics of Coal Pile Runoff	5-59
5.3-5 Trace Metals in Coal Pile Runoff	5-61
5.3-6 Concentration of Heavy Metals from Material Leachates	5-62
5.3-7 Chemical Properties of Discharge from Existing Partially Completed Ash Disposal Site in Western Pennsylvania	5-64
5.4-1 Summary of Significant Deterioration Analysis, Class II Areas, Florida Power Corporation, Crystal River Units 4 and 5, Citrus County, Florida	5-79
5.4-2 Summary of Significant Deterioration Analysis, Class I Area--Chassohowitzka National Wilderness Area, Florida Power Corporation's Units 4 and 5 Citrus County, Florida	5-82

CHAPTER 5

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
5.1-1 Annual Average Salt Deposition Amounts from Proposed Units 4 and 5 Cooling Towers	5-9
5.1-2 Projected Salt Deposition Rates on Plant Communities Remaining After Plant Construction	5-11
5.3-1 Location of Proposed Well Field and USGS Observation Wells	5-40
5.3-2 Map Showing Location of Existing Wells for Crystal River Units 1, 2, and 3, and Recently Installed Wells for Units 4 and 5	5-41
5.3-3 Potentiometric Surface of Upper Floridan Aquifer, May, 1975	5-49
5.3-4 Predicted Drawdown of Water Levels After Pumping Wells PW-1, PW-2, PW-3, and PW-4 for a Total of 3 mgd for 90 Days With No Rain	5-51
5.4-1 Estimated Annual Average Sulfur Dioxide Baseline Concentrations ($\mu\text{g}/\text{m}^3$) in the Vicinity of FPC Crystal River, 1974	5-72
5.4-2 Estimated Annual Average Total Suspended Particulate Baseline Concentrations ($\mu\text{g}/\text{m}^3$) in the Vicinity of Florida Power Corporation Crystal River, 1974	5-73
5.4-3 Estimated Annual Average Groundlevel Sulfur Dioxide Concentration ($\mu\text{g}/\text{m}^3$), for All Sources with Proposed Units, 1984	5-74
5.4-4 Estimated Annual Average Groundlevel Particulate Matter Concentrations ($\mu\text{g}/\text{m}^3$), for All Sources with Proposed Units and Fugitive Dust Sources, 1984	5-75
5.4-5 Estimated Annual Average Groundlevel Sulfur Dioxide Concentrations ($\mu\text{g}/\text{m}^3$), Florida Power Corporation, Incremental Impact of Florida Power Corporation	5-76
5.4-6 Estimated Annual Average Groundlevel Particulate Matter Concentrations ($\mu\text{g}/\text{m}^3$), Florida Power Corporation, Incremental Impact of Florida Power Corporation	5-77

5.0 ENVIRONMENTAL IMPACT OF PLANT OPERATION
 AND ASSOCIATED TRANSMISSION FACILITIES

This chapter will discuss the primary and secondary impacts associated with operation of the proposed power generating Units 4 and 5 at Crystal River.

5.1 HEAT DISSIPATION SYSTEM

As noted elsewhere, the potential impacts of the heat dissipation system would involve fogging and drift from cooling tower operation.

5.1.1 DETERMINATION OF MAXIMUM FOG POTENTIAL

Cooling towers can cause fogging when water vapor emissions from a cooling tower condense in the vicinity of the tower. This condition is analyzed in terms of the fogging potential which is linked to the "saturation deficit" of air near the tower. The saturation deficit of a moist air parcel is defined as the amount of additional moisture required to bring that parcel to saturation at constant temperature and pressure. The maximum fogging potential of a parcel exists when there is both a small saturation deficit of moisture and no dense fog occurring. If natural fog has already formed, saturation has been reached. Since all additional moisture will condense out immediately upon addition to the environment, there is no longer a potential for fog formation.

The maximum fogging potential for the Crystal River site was determined using ESE's FOGPTL computer model. The model determines the tabular and relative frequency distributions of wind speed and direction, both seasonally and annually, for each hour that the potential for cooling tower fog occurs. Hourly visibility data as well as ambient and dew point temperature data must be available to run the model. The Crystal River site tower records both temperatures, but visibility data are not

collected. For this reason, hourly data were used from Tampa, Florida, for 1964, as the most representative location having these data.

Fog is most likely to occur when there is a saturation deficit of 0.4 grams or less of water vapor per cubic meter. From the Tampa data, both the frequency of occurrence of saturation deficits of 0.4 grams or less per cubic meter, and the frequency of occurrence of dense fog (0.6 kilometers or less visibility) were compared. These variables, as well as the maximum fogging potential, are summarized by season in Table 5.1-1. A potential for cooling tower induced fog exists approximately 344 hours a year. Nearly 95 percent of this fog occurs from September through February.

When applying the model, the wind speed and direction are entered into a frequency distribution for each hour of fogging potential. This distribution indicates the areas around the tower which are most likely to be affected on a seasonal basis.

Table 5.1-2 portrays the annual wind distribution during maximum fogging potential hours. From a breakdown of wind directions into six wind-speed classes, it is evident that the great majority of these conditions experience wind speeds from 4 to 6 knots (1 meter per second = 1.9425 knots). When these occurrences are divided by all hours, the relative frequency of occurrence of wind distribution of fogging potential is calculated (see Table 5.1-3).

Table 5.1-1 shows how often maximum fogging is likely to occur in the vicinity of the proposed site. Fog formed in the tower would be most likely to occur in the southwestern quadrant from the tower. Therefore, a majority of the resulting impact will be toward the Gulf of Mexico. The value at each direction represents the frequency of occurrence in that direction and not the distance downwind that the plume would flow.

Table 5.1-1 Number of Hours of Saturation Deficit < 0.4 Gallons per Minute³, of Dense Fog, and of Maximum Fogging Potential--Tampa, Florida, 1964, 24 Observations Per Day

Season	Saturation Deficit	Dense Fog	Maximum Fogging Potential
Winter (DJF)	190	24	166
Spring (MAM)	10	2	8
Summer (JJA)	12	0	12
Autumn (SON)	179	21	158
Annual	391	47	344

Source: Environmental Science and Engineering, Inc., 1977.

Table 5.1-2 Wind Distribution of Maximum Fogging Potential

Wind Direction	Wind Speed Class (KTS)						TOTAL
	0-3	4-6	7-10	11-16	17-21	GT21	
N	1	18	29	3	1	0	52
NNE	0	15	18	4	0	0	37
NE	1	17	21	6	0	0	45
ENE	2	27	32	9	0	0	70
E	1	17	16	0	0	0	34
ESE	2	9	6	1	0	0	18
SE	2	4	10	1	0	0	17
SSE	0	5	9	1	0	0	15
S	1	6	21	6	2	0	36
SSW	0	0	1	2	0	0	3
SW	0	1	0	0	0	0	1
WSW	0	1	1	0	0	0	2
W	0	0	1	1	0	0	2
WNW	0	0	1	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	1	1	0	0	0	2
CALM	9						9

Hours with heavy fog (3/8 mile or less visibility) = 47

Hours of saturation deficit less than or equal to 0.4 gallons per cubic meter = 391

Maximum fogging potential hours = 344

Source: Environmental Science and Engineering, Inc., 1977.

Table 5.1-3 Relative Wind Distribution of Maximum Fogging Potential

Wind Direction	Wind Speed Class (KTS)						TOTAL
	0-3	4-6	7-10	11-16	17-21	GT21	
N	0.00011	0.00205	0.00330	0.00034	0.00011	0.0	0.00592
NNE	0.0	0.00171	0.00205	0.00046	0.0	0.0	0.00421
NE	0.00011	0.00194	0.00239	0.00068	0.0	0.0	0.00512
ENE	0.00023	0.00307	0.00364	0.00102	0.0	0.0	0.00797
E	0.00011	0.00194	0.00182	0.0	0.0	0.0	0.00387
ESE	0.00023	0.00102	0.00068	0.00011	0.0	0.0	0.00205
SE	0.00023	0.00046	0.00114	0.00011	0.0	0.0	0.00194
SSE	0.0	0.00057	0.00102	0.00011	0.0	0.0	0.00171
S	0.00011	0.00068	0.00239	0.00068	0.00023	0.0	0.00410
SSW	0.0	0.0	0.00011	0.00023	0.0	0.0	0.00034
SW	0.0	0.00011	0.0	0.0	0.0	0.0	0.00011
WSW	0.0	0.00011	0.00011	0.0	0.0	0.0	0.00023
W	0.0	0.0	0.00011	0.00011	0.0	0.0	0.00023
WNW	0.0	0.0	0.00011	0.0	0.0	0.0	0.00011
NW	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNW	0.0	0.00011	0.00011	0.0	0.0	0.0	0.00023
CALM	0.00102					0.0	0.00102

Total number of hours read = 8784

Source: Environmental Science and Engineering, Inc., 1977.

This methodology for tabulating the maximum fogging potential in the vicinity of a cooling tower derives its results from meteorological considerations only and may be conservative in nature. Actual occurrences of ground-level fogging will be affected by the elevated release point. Since cooling towers at Units 4 and 5 will be 140 meters in height, the visible plume may have ample time to disperse before contacting the land surface. Because of relatively high ambient temperatures, it is highly improbable that an icing condition will ever develop.

Implications

It is very unlikely that cooling tower fogging associated with the proposed Crystal River Units 4 and 5 will have significant negative impacts on air or highway transportation. When it occurs, fogging will be highly localized, extending no more than 1.5 kilometers from each cooling tower. Plumes will not reach a sufficient height to affect aircraft. The only highway which could be affected significantly by cooling tower fogging, other than the Florida Power access roads, would be U.S. Route 19-98, located more than 5 kilometers (3 miles) east of the proposed plant site. As already noted, fogging will occur primarily to the southwest of the cooling towers, and is expected to involve much shorter distances than 5 kilometers. Thus, extraordinarily rare circumstances would be required for cooling tower fogging to affect traffic on U.S. 19-98.

Fogging could possibly affect water navigation on the intake canal, however, since the canal extends fairly close to the proposed cooling towers and lies in the direction of greatest fog potential. The traffic thus affected would be limited almost entirely to fuel shipments to the plant. It is projected that hazards could be kept to minimal levels through the exercise of prudent vessel control and reliance upon radio communication during the infrequent periods when fogging occurs.

5.1.2 COOLING TOWER DRIFT

A study (Black and Veatch, 1978) was made to determine the amount of deposition from salt drift in the vicinity of the two proposed natural draft cooling towers. The towers will be built adjacent to their respective power-generating units and will stand 140 meters (460 feet) above grade. Efficient drift eliminators on both towers will be used, and the mass fraction of circulating salt water which will be carried out from the tower as drift will not exceed 0.0005 percent.

The two towers are close together and will have some interaction of drift and fog. However, for the purposes of this analysis, the towers were assumed to be at the same location. The resulting estimates of maximum salt concentrations therefore are more conservative (tend to overestimate the actual concentrations) than considering slightly separated towers.

Salt deposition due to the operation of the proposed towers has been predicted by the Oak Ridge Fog and Drift Code, which is a dispersion model with moist plume rise calculations being performed for several different relative humidity conditions, Pasquill stability classes, and wind speeds. A variable number of years of meteorological surface observation data was read into the model to determine the deposition and drift in an "average year". One distinctive advantage of the model is the capability of obtaining contour maps of the amount of salt drift, fog, ice fog, and the amount of salt in the air.

Five drift particle sizes selected for use in the model were 31, 58, 110, 210, and 800 microns, with each size comprising one fifth of the drift particles. Meteorological data utilized in the model were a 10-year record from Tampa, Florida, the nearest and most representative weather office where all necessary surface observations are available.

The maximum salt deposition expected at the site is 12.8 grams/meter²/year (112.4 pounds per acre per year) and will occur 0.3 kilometers [0.2 miles west of the towers (see Figure 5.1-1)]. At distances beyond 1.3 kilometers (0.8 miles), only residual drift from the smallest particles will be observed. The maximum deposition rate beyond this point seldom will exceed 1.7 grams/meter²/year (15 pounds per acre per year).

With an estimated background level of salt deposition of 3.4 grams/meter²/year (30 pounds per acre per year), the total deposition in nearly all areas within 0.8 kilometers (0.5 miles) of the towers will not exceed 9 grams/meter²/year (80 pounds per year).

The effects of saltwater drift from a natural draft cooling tower can be divided into two categories:

1. The effects upon the site environs, and
2. The effects upon the station structures and equipment.

Salt drift droplets contain almost the same concentration of chemicals that are found in the circulating water, including the inhibitors. The drift is deposited in the form of droplets or solid particles, depending on the atmospheric conditions, and leaves precipitants of chemicals on different surfaces located in downwind directions from the tower. The chemicals can cause damage to the biota and structures, depending upon the concentration and composition of these chemicals.

A comparison of natural background salt levels and salt drift from cooling towers reveals that the deviations between the two can reach a factor of ten or more, depending upon the location and atmospheric conditions. Under high-humidity conditions and low-wind speeds, the salt drift can match the natural background a short distance inland. With relative humidities less than 70 percent, the salt deposition from the tower will be smaller by a factor of 10 or more. The ocean is

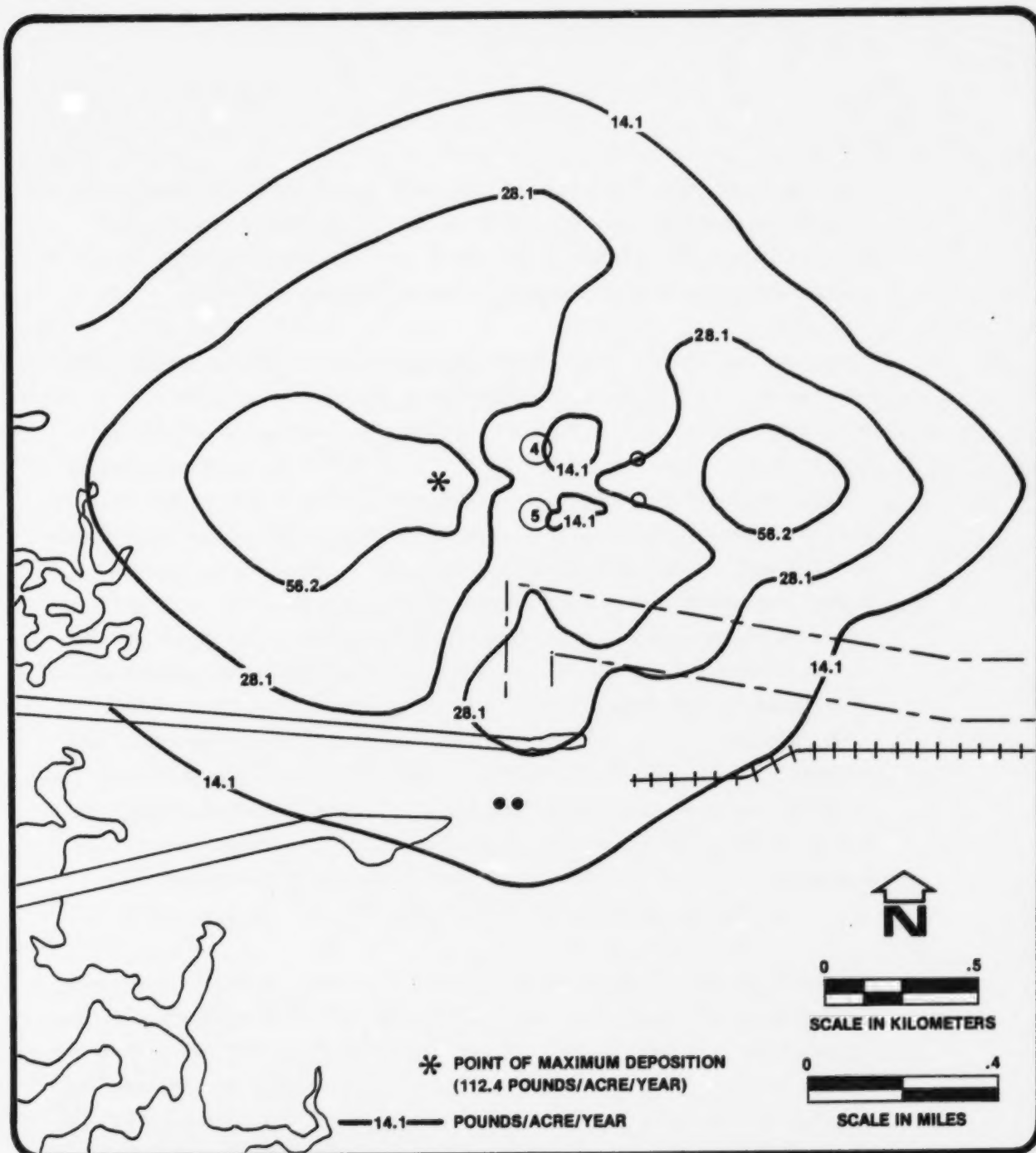


Figure 5.1-1
ANNUAL AVERAGE SALT DEPOSITION AMOUNTS FROM
PROPOSED UNITS 4 AND 5 COOLING TOWERS

SOURCE: BLACK AND VEATCH, 1977

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

considered to be a vast ground level area source while the towers are considered elevated points or line sources. In coastal areas, the natural background levels of salt will have already determined to a large degree the biotic composition and community parameters.

There are two plants currently in operation in the United States which use natural draft towers with brackish water as makeup. The B.L. England Unit 3 of Atlantic City Electric Company, a 160-megawatt plant in New Jersey; and Chalk Point of Potomac Electric Power Company, a 1,260-megawatt facility in Maryland, both use hyperbolic natural draft cooling towers (Kaplan, 1977). The Chalk Point towers take in saltwater as high as 26 parts per thousand (Pell, 1975) and the B.L. England towers use water with a salt concentration as high as 22 parts per thousand (Kaplan, 1977). Measurements of salt drift for these towers indicate that a lower ratio of drift to circulating water volumes than guaranteed by the manufacturers has been produced (Monjoie and Sobel, 1976; Kaplan, 1977). Monjoie and Sobel reported a measured drift rate of about .0005 percent for the B.L. England plant. EPA researchers working with test facilities (single-cell, mechanical draft tower) at Turkey Point, Florida, found no statistically significant increase in background salt concentrations of approximately 900 kilograms (2,000 pounds) per day for the study area (Shirazi, et al., 1977).

The point at which maximum salt deposition [10.6 kilograms per hectare per month (112.4 pounds per acre per year)] at the Crystal River site occurs lies just east of the eastern edge of the coastal hydric hammock to the west of the plant complex (Figure 5.1-2). This entire stand of coastal hydric hammock and coastal hammock in the northern half of the Florida Power Corporation property will receive deposition at rates greater than 2.6 kilograms per hectare per month (28.1 pounds per acre per year). This deposition rate will also occur over an additional 8 hectares (20 acres) of coastal hydric hammock and 18 hectares (45 acres) of pine plantation off of the Florida Power Corporation Property north of the site, 8 hectares (20 acres) of pine flatwoods, and

minor areas of mesic hammock, freshwater marsh, and early successional areas.

The most extensive studies to date on the effects of saline cooling tower drift were made as part of the Chalk Point Cooling Tower Project in Maryland (Curtis, et al., 1978). That study included a series of experiments on the impact of saline aerosols on seedlings of several perennial woody species. Of the species studied, only dogwood (Cornus florida) was found to exhibit sufficient injury symptoms to be useful as a bioindicator at the concentrations expected under most cooling tower operation conditions (Curtis, et al., 1976).

At a simulated deposition rate of 20 kilograms per hectare per month (216 pounds per acre per year), they found that resulting leaf chloride levels of 3,466 to 6,124 ug/gdw caused injuries in about 5 percent to 40 percent of the leaves (Curtis, et al., 1978). Statistical correlations indicated a threshold leaf injury level in dogwood of 7.46 kilograms per hectare per month (80.63 pounds per acre per year). Their conclusion was that "some injury may occur to a sensitive species such as dogwood under certain cooling tower operations," as based on an estimated maximum deposition rate of 8.1 kilograms per hectare per month (87.5 pounds per acre per year) at Chalk Point. Francis (1977) has also found indications of possible chloride retention in woody tissues and increased accumulation in the leaf in following years.

Using this information, it appears that at the point of estimated maximum deposition of the Crystal River Units 4 and 5 [10.6 kilograms per hectare per month (115 pounds per acre per year)] leaf injuries of over 50 percent could theoretically occur in species which may be as sensitive as dogwood. Such an impact would, in all likelihood, cause a significant reduction in growth and survival of affected individuals.

The entire 49.7 hectares (122.8 acres) of coastal hydric hammock remaining west of the plant site will receive a minimum deposition of

2.6 kilograms per hectare per month (28 pounds per acre per year). Most of this area will receive a rate well below the presumed injury threshold for sensitive species and thus will not be adversely affected. However, portions will receive values up to 10.6 kilograms per hectare per month.

It should be emphasized that such an analysis is based upon a limited amount of data collected in controlled field experiments. Although such data is probably more applicable than greenhouse studies, it should be extrapolated to natural situations only with caution. Tolerance of individual species varies tremendously, even within genera. Nutrient status and other soil and environmental factors also influence tolerance levels.

Another factor complicating the analysis is the ambient level of deposition at a specific location. If ambient levels are high, an additional cooling tower-induced deposition rate lower than those described above may be sufficient to cause injury as the combined deposition rate surpasses the threshold level.

There is currently no dependable data available on the ambient deposition rate and internal leaf chloride concentration at the site. Therefore, background effects can be inferred only from an ecological evaluation of existing vegetation.

It has often been shown that zonation of vegetation occurs in response to gradients in specific environmental factors, and that such a community response is based upon the tolerance levels of individual species. On the Atlantic Coast of the United States, numerous studies have shown zonation in sand dune communities and maritime live oak forests to be due to the effects of salt spray caused by wind along these high energy coasts (Oosting and Billings, 1942; Boyce, 1954; Martin, 1959). Characteristics of such zonation include a reduction of species near the source and a reduction in canopy height causing a sheared appearance.

The Crystal River area of the Gulf Coast is a lower energy system than that of the east coast with less wind, wave, and storm action, and presumably less salt spray. This is evidenced by the physiognomic profile of the coastal forest, in which the shear effect is not seen in the canopy, implying that salt spray is not a limiting factor in this system and does not reach injury levels for the indigenous species. A survey of salt content in soil and on leaves in the area also showed no correlation to distance from the sea (Dames and Moore, 1974).

Although these findings indicate that salt deposition is not a limiting factor in this system, they do not indicate the degree to which salt deposition approaches injury threshold levels. The findings also cannot indicate whether or not additional deposition of amounts below threshold levels will be sufficient to cause injury.

It may also be inaccurate to project tolerance levels to these species based on results for similar species since tolerance levels do not appear consistent among similar species. However, some generalizations might be made. Boyce (1954) has described correlations between tolerance and the degree of hypertrophy or succulence (cell enlargement due to salt). Live oak, sweetbay, red maple, loblolly pine, and persimmon, of which are found near the Crystal River site, were all found to lack the ability to respond. Therefore, it appears that there is some possibility of salt drift injury to the more sensitive species in some portions of the coastal hydric hammock, but in other plant communities there is a low likelihood of injury occurring. Since neither the tolerance levels of these species nor the background salt drift levels are known, it is not possible to predict the extent, if any, of such impacts. However, field surveys have failed to detect injury to neighboring vegetation during operation of the Atlantic City Electric B.L. England plant or the Potomac Electric Power Company Chalk Point Station, and similar results are likely to be found at Crystal River.

At Crystal River, the effects of saltwater drift on the station structures and equipment, particularly the substation, are of importance. The effects of salt deposition upon structures depend upon the types of structural materials and amount of salt accumulated on their surfaces. The amount of salt deposition depends upon source strength, distance from the source, wind speed and direction, time the droplets remain upon the surface, relative humidity, and amount of precipitation (Roffman, et al., 1973). The design engineers, Black and Veatch, have indicated that any additional salt drift (30 pounds per acre per year) beyond natural background would cause operational problems at the new or existing facility.

The corrosion rate caused by natural sea drift falls off rapidly with increasing distance from the sea. Studies show that in coastal areas, the corrosion rates of iron, stainless steel, and aluminum decrease by factors of 10, 3, and 21, respectively, as the distance increases from about 25 meters (80 feet) to about 250 meters (800 feet) inland (Roffman, et al., 1973). High precipitation rates tend to wash off the salt and thus reduce the corrosion rate, but high humidity and fog keep the surface wet and enhance corrosion. Structures in warm areas, with long periods of exposure to sunshine, experience less corrosion due to the fast evaporation of the droplets.

In the case of the Crystal River facility, the incremental adverse effects of salt deposition at distances greater than about 0.5 kilometer (0.3 mile) downwind are expected to be insignificant. Some adverse effects are expected only in the immediate proximity of the tower, the Units 4 and 5 facilities, and the existing substation and transmission lines. These effects are due to localized phenomena, e.g., blowout in the case of counterflow towers and wake effects. Blowout consists of a spray of droplets removed from the water falling into the tower basin, and is carried out by air movement in the lower portion of the tower. Hence, metal structures, high-voltage power lines, and buildings in these areas must be protected by suitable coatings, as reported by

FPCR4/5-TSD5.1/R5-1.11
3/25/80

saltwater cooling tower users. Also, parking lots should not be placed at short distances downwind of the tower.

5.1.3 BIOLOGICAL IMPACTS OF IMPINGEMENT AND ENTRAINMENT

IMPINGEMENT

The cooling-water intake site for Units 4 and 5 will be located on the north bank of the discharge canal presently serving Units 1, 2, and 3. This intake structure will consist of three cells, and is described in detail in Section 3.4.1. Each cell will have a 4.6-meter (15-foot) wide traveling screen which passes over two horizontal axles. Screen backwash will be accomplished by pumps leading to high-pressure spray nozzles.

These screens (3/8-inch mesh) are run in both manual and automatic modes. The automatic operation is a consequence of greater "upstream" hydraulic head or water pressure gradient as impingement of organisms on the screens increases with time. The intake pumps will create an intake water velocity of 0.04 to 0.15 meters per second (0.12 = 0.5 foot per second maximum flow rate at lowest water level), which complies with current EPA intake velocity design criteria of 0.15 meters per second (0.5 foot per second). The net flow of water downstream in the discharge canal, from Units 1, 2, and 3, is currently 0.43 meters per second (1.4 feet per second). The present discharge flow rate from these three units in normal operation is 0.08 million lps (1.322 million gpm). Located immediately in front of the traveling screens will be barrier nets, floating booms, and/or trash racks to deflect various debris, flotsam, and large swimming organisms.

The existing data relative to screenwash impingement and the Crystal River electric generating facility is contained in studies of Units 1, 2, and 3 intake waters. The first study was a 1969-1971 Florida Department of Natural Resources screenwash monitoring program, reported by Grimes (1971) and Mountain (1972). The second study, conducted by the University of Florida, was reported by Snedaker (1974) and will

serve as the "touchstone" for most comments concerning impingement for Units 1, 2, and 3.

Within the intake canal, the small, juvenile, and weak-swimming species became impinged throughout the year, whereas the strong-swimming, larger species were impinged in the colder months of the year. Of the 164 species Snedaker (1974) recorded during his 52-week study, eight of the ten most abundant species were relatively slow-swimming fishes or macroinvertebrates and accounted for 95.6 percent of the total biomass collected during this period. Seven species of fishes and invertebrates were collected during each of these 52 weeks. Four of these species were slow-swimming forms which were among the ten most abundant species mentioned above. They included the polka-dot batfish (Ogcocephalus radiatus), the striped burrfish (Chilomycterus schoepfi), the blue crab (Callinectes sapidus), and the Cephalopoda (squids). Fish of commercial or recreational importance accounted for only 7.8 percent of the total biomass collected during the study.

To facilitate analyses, Snedaker (1974) arranged the impinged species into their respective habitat groups, as follows:

- Migratory species (pulsed impingement)
- Grass-mat dwellers and/or trackers
- Bottom dwellers (over mud or sand)
- Large, fast-swimming--top, midwater
- Large, fast-swimming--bottom
- Slow, weak-swimming forms
- Schooling species
- Sessile species (macroinvertebrates)

Impingement was found to be a source-dependent process, a function of habitat, area, season, time-of-day, tide, and fuel barge movements. Top and mid-water swimmers tend to be impinged on the downstream screens.

Currently there is a lack of baseline research on impingement-prone species now resident in the discharge canal. No known studies exist for fishes and other nekton found there. In a study of fishes taken in dropnet collections from nearshore intake and discharge waters, Adams (1974) found that over 40 percent of the species recovered in his study never occurred in the discharge area. The species composition of fishes was less "rich" in the discharge waters.

In terms of source areas for nekton (and, therefore, impingement-prone species, the situation is quite different in the discharge canal as compared to the intake canal waters. On-site observations indicate that the most common and/or abundant fishes of the discharge canal tend to be larger, schooling forms, which include the following:

- Sharks (eps. Carcharinus limbatus, uncommon)
- Mullet (Mugil spp.)
- Ladyfish (Elops saurus)
- Tidewater silverside (Menidia beryllina)
- Pinfish (Lagodon rhomboides)
- Spotted seatrout (Cynoscion nebulosus)
- Atlantic croaker (Micropogon undulatus)
- Red drum (Sciaenops ocellata)
- Spot (Leiostomus xanthurus)
- Silver perch (Bairdiella chrysura)
- Jacks (Caranx spp.)

The discharge canal constitutes a physical "dead-end" for upstream swimmers. Benthic sediments collected halfway down the discharge canal have been examined and sieved, revealing no macroinvertebrate organisms. Large numbers of spot and pinfish have been recovered by cast-netting. The subsequent dissection of hundreds of specimens revealed empty gut cavities, indicating no feeding activity. During the colder, winter months, fishes such as red drum (redfish, channel bass) are subject to intense recreational angling pressure. Fishermen frequent the discharge

canal during this period, seeking those fishes attracted to the warmer power plant discharge effluent (Adams, personal observations).

In summary, those species available for impingement as a consequence of Units 4 and 5 intake operations would be of a vastly different composition than those identified as impinged by Units 1, 2, and 3 intakes. Since those species available for interaction with the new intake structure would generally be larger, faster-swimming forms, it is anticipated that the impingement which does occur would be much less, relative to water volume and flow, than seen at the Units 1, 2, and 3 intake structures. Also, there would be less impingement due to the reduced intake volume and velocities of Units 4 and 5.

ENTRAINMENT

Potential impacts relating to the entrainment of plankton populations include: (1) reduced levels and permanent loss of production that would otherwise be available to the system; (2) alteration of the trophic structure of the biological community as a result of significant losses of plankton species; and (3) losses of commercially important species that are known to spend part of their life cycle as members of the plankton community. Mortality of entrained plankton populations occurs through mechanical damage of the organism and thermal shock resulting from elevation of water temperatures.

Zooplankton entrainment investigations on withdrawal of cooling waters for Crystal River Units 1, 2, and 3 have indicated that mechanical damage, which seems to have a greater effect on larger zooplankton species (e.g., Labidocera sp. and Acartia tonsa), accounts for a smaller percentage of mortality than that induced by elevated temperatures (Mature, et al., 1974). The aforementioned study reported entrainment mortalities ranging from 0 to 45.6 percent. The lowest number of deaths were found to occur within the cooler months of

the year, and nearly exponential increases were recorded when the discharge temperatures rose above 35°C during late summer.

According to Jensen, et al., (1969) the rate of change in temperature may be of greater significance to the survival of these organisms than the amplitude of the change. A rapid change in temperature does not allow sufficient time for necessary physiological adjustments. Since many of the zooplankton individuals inhabiting the discharge canal have entered the system through the condensers of Units 1, 2, and 3, they have already been subjected to a rapid temperature change which may have been as great as 8°C during certain months of the year. It is anticipated that near 100 percent mortality will occur when these individuals are further subjected to additional rapid increases in temperature through entrainment in intake waters being withdrawn from the discharge canal for Units 4 and 5.

Secondary impacts related to the chemical constituents of cooling tower waters include the effects of increased salinity due to evaporation and the addition of chlorine as a biocide. Entrained plankton as well as plankton in the immediate vicinity of the blowdown discharge will be affected by these factors.

Maturo, et al. (1974), recorded apparent general temperature-salinity interactions where low salinity/high temperature and high salinity/low temperature combinations resulted in increased copepod mortalities. These potential impacts are considered to be minimal or insignificant. This assumption is based on: (1) the predicted 100 percent mortality following initial entrainment through the condensers of Units 4 and 5; (2) the predicted high velocities and rapid mixing of blowdown discharge and discharge canal waters.

The residual chlorine concentration in blowdown discharge water is predicted to be approximately 0.2 mg/l which falls below the Environmental Protection Agency's specified level of 0.5 mg/l. The concentration will

approach zero-free residual chlorine upon dilution by discharge canal waters. Although low chlorine concentrations have been shown to produce adverse effects on phytoplankton (Carpenter, et al., 1972; Gentile, et al., 1973), the impact is considered to be low in both magnitude and significance.

Several studies to date which have addressed the survivability of young/small fish entrained through a power plant have shown inconclusive results. However, Marcy (1971, 1973) showed that most fish larvae and early juveniles entrained through a Connecticut River power plant were dead when they reached the end of a 2.25 kilometer (1.14 mile) discharge canal. Examination of entrained alewives, herring, white perch, carp, eels, spottail shiner, darters, and shad revealed a mortality of 100 percent for nine out of ten collection series (one showed 92.5 percent mortality at the last downstream collection station). Marcy estimated that approximately 80 percent of the total mortality was caused by mechanical damage and 20 percent was attributed to heat shock and prolonged exposure to temperatures above 28°C. There was "no measurable mortality due to injection of sodium hypochlorite as a biocide." The majority of dead specimens were physically mangled, a condition more obvious in larger specimens. Increases in mechanical injury directly proportional to the size of entrained fishes have been reported by Markowski (1962), Oglesby and Allee (1969), and Marcy (1971). It has been noted that high negative pressures created with the cooling water by pump impeller blades may be largely responsible for destruction of fish tissue.

Intake structures will require less than 160 cubic yards of dredging, which will be conducted during a period of one month. This activity will result in the disruption of a small area of benthic community and in slightly increased turbidity. In compliance with state licensing, construction of intake and discharges must be done in a manner to minimize turbidity. Sheetpile or turbidity screens must be used if necessary to prevent turbidity in excess of 50 Jackson Turbidity Units

(JTU) above background beyond 150 meters from the point of discharge and/or construction site. Due to the small volume of dredged material and the short time period of dredging activity, these impacts are not considered significant.

Considering the present thermal loading and mechanical impact of Units 1, 2, and 3 discharge water prior to use in Units 4 and 5 condenser cooling system, it is anticipated that 100 percent mortality will occur for all fishes of unscreenable (entrainable) size which enter the Units 4 and 5 intakes. Nevertheless, the overall impact of Units 4 and 5 on entrainment are not considered significant.

Due to the location (on existing discharge canal), design (flush-mounted with canal wall, low intake velocity), construction plans (minimal dredged volume over a short period), and capacity (cooling towers minimize usage), EPA has tentatively determined that the proposed cooling water intake structure reflects the best technology available for minimizing adverse environmental impacts in accordance with Section 316(b) of the Clean Water Act.

5.2

IMPACTS ON SURFACE WATERS

5.2.1 SUMMARY OF WASTEWATER DISPOSAL SYSTEMS

The proposed power generating Units 4 and 5 at Crystal River will yield wastewaters from a variety of different sources, as detailed in Chapter 3. This sub-section summarizes these wastewaters and the manner in which they will be disposed as background to the discussion of potential impacts on surface and ground water systems.

The process wastewaters from the proposed units will include: low-volume wastes (sludge and backwash water from the service water pretreatment system; cooling tower desilting; regenerant wastewaters from the demineralization and condensate polishing system; cleaning and maintenance wastewaters); steam cycle losses; ash sluice waters; sewage treatment plant effluent; metal-cleaning wastes; and cooling system blowdown. Chemical cleaning wastes will be generated by batch boiler cleaning operations at one- to three-year intervals. Rainfall runoff from the plant and material storage areas will be discharged only from storms exceeding a quantity of water equivalent to the 10-year, 24-hour storm (8.37 inches). A critical feature of the project design is the manner in which these wastewaters will be released to the environment or otherwise disposed. Table 5.2-1 presents a water balance for each of the major facilities that will generate, receive, or transmit wastewater. These are the ash handling and storage areas, the coal storage area, the cooling tower blowdown, the plant drains collection pond, the runoff collection and retention system, and the existing discharge canal. With the exception of cooling tower drift, all release of wastewaters to the environment will take place through these facilities. Only material storage runoff and cooling tower blowdown will be discharged to surface waters.

All of the flow rates shown in Table 5.2-1 pertain to normal plant operation (66 percent average capacity factor) and thus represent

Table 5.2-1 Wastewater Flow Summary

		Normal Flow	
		dm ³ /s	gpm
<u>I. Ash Handling and Active Ash Storage Areas</u>			
Inflows			
Service water pretreatment wastewaters	0.5	8	
Service and hydraulic sluice water	3.5	55	
Dust suppressant water from			
Plant Drains Collection Pond	0.4	5	
Rainfall	3.6	57	
Losses			
Evaporation	-3.0	-47	
Exfiltration	-3.5	-55	
Storage			
NET MOISTURE ACCUMULATION IN ASH	1.5	23	
Surface Discharge (To Runoff Collection			
Retention System)	0.0	0	
Total	1.5	23	
<u>II. New Coal Storage Area</u>			
Inflows			
Rainfall	9.0	142	
Losses			
Exfiltration	-8.6	-136	
Evaporation	-0.4	-6	
Surface Discharge (To Runoff Collection			
Retention System)	0.0	0	
Total	0.0	0	
<u>III. Plant Drains Collection Pond</u>			
Inflows			
Cleaning and maintenance wastewaters	3.2	50	
Demineralization and condensate polishing			
wastes (from neutral basin)	1.3	21	
Boiler blowdown	5.1	81	
Direct rainfall	1.1	18	
Losses			
Flow to ash storage area for dust control	-0.3	-5	
Evaporation	-0.9	-15	
Exfiltration	-9.5	-150	
Surface Discharge (To Cooling Tower			
Blowdown Conduit)	0.0	0	
Total	0.0	0	

Table 5.2-1 Wastewater Flow Summary (Continued, page 2 of 2)

		Normal Flow	
		dm ³ /s	gpm
IV.	<u>Runoff Collection and Retention System</u>		
	Inflows		
	Runoff from general site area	5.4	85
	Runoff from new coal storage area		0
	Runoff from ash storage area		0
	Direct rainfall	0.5	8
	Runoff from plant roof drains	1.3	20
	Losses		
	Evaporation	-0.5	-7
	Exfiltration	-6.7	-106
	Surface Discharges (To Existing Cooling Water Discharge Canal)	0.0	0
	Total	0.0	0
V.	<u>Existing Cooling Water Discharge Canal</u>		
	Inflow from Crystal River Units 1, 2, and 3		
	Peak operating flow	83,400	1,322,000
	Minimum operating flow	20,850	330,500
	Crystal River Units 4 and 5		
	Cooling tower blowdown	3,852	61,142
	Cooling tower makeup	4,284	68,000
	Runoff collection and retention system	0	0

Source: Black and Veatch, 1980.

long-term averages. Most of the figures would be higher for peak operating conditions with the exception of rainfall, surface runoff, and maintenance wastewaters. None of the facilities listed in Table 5.2-1, other than the cooling tower blowdown, will discharge effluents continuously to surface waters. Rainfall runoff which exceeds the volume of storage in excess of the 10-year, 24-hour storm design criteria will also be discharged. The active ash storage area will accumulate water used for dust control at an average rate of $1.5 \text{ dm}^3/\text{s}$ (23 gallons per minute) in the interstitial pores of the ash. All major water losses from the site, except the discharge of cooling system blowdown water to the existing discharge canal, will be by evaporation and exfiltration. Exfiltration will be the dominant mechanism of water loss, accounting for an average total flow of $28.4 \text{ dm}^3/\text{s}$ (447 gallons per minute) from the facilities listed, as opposed to an overall evaporation rate of $4.8 \text{ dm}^3/\text{s}$ (75 gallons per minute).

The plant drains collection pond will receive a variety of wastewaters and will be designed for complete retention with respect to surface water outflow. Evaporation and exfiltration are the only means by which wastewater is expected to leave the pond.

The canal retention system, which will receive surface runoff from the plant site, roof drains, and material storage areas developed as part of the present project, will also be designed to contain all runoff from a 10-year, 24-hour storm. Due to the high transmissivities of the surficial sands and underlying limestone, a substantially greater quantity of storm water may be required to produce overflow.

5.2.2 COOLING SYSTEM BLOWDOWN

The primary source of chemical and biocide discharge to surface waters will be the cooling system blowdown to the existing discharge canal for Crystal River Units 1, 2, and 3. The quantity to the canal will be $4,284 \text{ dm}^3/\text{s}$ (68,000 gallons per minute) at 1.1 to 1.2 cycles of concentration. The cooling tower blowdown will be diluted in the discharge canal by the flow of seawater used for once-through cooling in Crystal River Units 1, 2, and 3. The once-through cooling flow will vary from $83,400 \text{ dm}^3/\text{s}$ (1,322,000 gallons per minute) at maximum flow-through conditions for Crystal River Units 1, 2, and 3 to $20,850 \text{ dm}^3/\text{s}$ (330,500 gallons per minute).

The cooling towers will be operated at 1.1 to 1.2 cycles of concentration. The cycles of concentration in the tower will be controlled by the upper limit of 1,300 mg/l of calcium hardness as CaCO_3 required for the circulating water. The ambient salinity in the discharge canal averages approximately 25 parts per thousand. The blowdown discharge would have a salinity ranging from 32 to 50 parts per thousand for average intake salinities. The discharge canal is well mixed both horizontally and vertically due to the high discharge velocities from Crystal River Units 1, 2, and 3. Consequently, the formation of a stable salinity or thermal plume of blowdown water is unlikely. The turbulence in the canal should cause all discharge waters to be well-mixed at the bulkhead line. Chemical discharges should be well-mixed at 150 meters.

Six operational scenarios were developed for the Crystal River power complex in order to identify and evaluate the worst-case condition for thermal and other impacts in the discharge canal. The operational status for Crystal River Units 1, 2, and 3 for each scenario follows. Crystal River Units 4 and 5 were assumed to be operating at peak capacity at 1.2 cycles of concentration in all scenarios with a make-up inflow of 68,000 gpm and a blowdown discharge of 61,142 gpm.

Scenarios 1, 2, 3, and 4 could occur at any time after Crystal River Units 4 and 5 are on-line. Scenarios 5 and 6 could occur after Crystal River Units 1 and 2 have reached their 30-year operational life and have been decommissioned. This is scheduled to happen early in the 21st century.

The six scenarios evaluated are defined as follows:

Scenario	Unit 1	Unit 2	Unit 3	Units 4 and 5
1	Peak	Peak	Peak	Peak
2	Temp. Shutdown	Peak	Peak	Peak
3	Peak	Temp. Shutdown	Temp. Shutdown	Peak
4	Peak	Peak	Temp. Shutdown	Peak
5	No-Flow	No-Flow	Temp. Shutdown	Peak
6	No-Flow	No-Flow	Peak	Peak

The evaluations were made for both winter and summer ambient conditions with average intake canal temperatures of 57.0°F and 85.0°F for the months of January and July, respectively. Ambient salinity was assumed at 25 parts per thousand with a specific heat of 0.971 Btu/pound. Blowdown was assumed to have a salinity of 35 parts per thousand and a specific heat of 0.963 Btu/pound.

Operating conditions for Crystal River Units 1, 2, and 3 were assumed as follows:

Crystal River Unit Number	Flow (gpm)	Operating Condition	T (°F)
1	310,000	Peak	+13.0
	77,500	Temporary shutdown	0
2	330,000	Peak	+15.0
	82,500	Temporary shutdown	0
3	682,000	Peak	+17.5
	170,500	Temporary shutdown	+ 1.0

The results of the analysis are presented in Table 5.2.2.

Table 5.2.2 Summary of Cooling Tower Thermal Impact

Operating Scenario	$\frac{\left[\text{Thermal Energy Added to Canal By Blowdown} \right]}{\left[\text{Thermal Energy Extracted By Makeup} \right]}$ (Q_{BT}/Q_{MTM})*		Temperature at Cooling Tower Intake °F		Temperature at Bulkhead Line °F		Percent Blowdown**
	Jan.	July	Jan.	July	Jan.	July	
1	1.06	0.85	72.8	100.8	73.8	100.6	4.9
2	1.07	0.86	72.5	100.5	73.3	100.3	6.0
3	1.20	0.93	64.5	92.5	66.0	91.7	12.4
4	1.13	0.90	68.3	96.3	69.0	95.5	8.2
5	1.33	1.003	58.0	86.0	68.5	89.7	59.7
6	1.04	0.84	74.5	102.5	75.5	101.9	10.0

* If ratio is: >1: Net thermal increase to discharge canal
<1: Net thermal decrease to discharge canal
=1: No net thermal change

** Percent Blowdown = $\frac{\text{Blowdown Flow}}{(\text{CR } 1,2,3) - (\text{Makeup})} \times 100$

Blowdown as a percentage of total canal flow.

Note: This analysis did not consider evaporative cooling in the discharge canal proper. Consequently, the analysis is conservative (in that temperatures are overestimated).

Average Cooling Tower Blowdown Temperatures:

January—86°F

July—96°F

Average Ambient Gulf Waters:

January—57°F

July—85°F

Source: Environmental Science and Engineering, Inc., 1980.

The dilution ratio (discharge from Crystal River Units 4 and 5 relative to discharge from Crystal River Units 1, 2, and 3 minus makeup flow) ranges from 4.9 to 59.7 percent.

The cooling tower blowdown will be taken from the cold side of the circulating water system. The chemical characteristics of blowdown water from Units 4 and 5 have been presented in Chapter 3. The constituents having significant potential for ecological impact are chlorine, organic phosphates, and sulfuric acid. Shock chlorination will be used to control bacterial slimes, fouling organisms, and algae. A chlorine solution will be pumped to the cold side of each unit 1 to 3 times per day. One unit will be chlorinated at a time, with intervening periods of no chlorination.

Shock chlorination of the cooling system will yield a total residual chlorine concentration in the blowdown which will not exceed 0.1 milligrams per liter at any one time, in compliance with the draft NPDES permit. Dechlorination facilities may be required. Instantaneous concentrations of total residual chlorine in the discharge canal at the edge of the 150-meter mixing zone is not expected to exceed the Florida Water Quality Standards criterion of 0.01 mg/l of total residual chlorine. However, to assure that this degree of dilution can be achieved, Florida Power Corporation will be required to conduct dye dispersion studies prior to finalization of the Final EIS (FEIS). The use of an organic phosphate scale inhibitor will generate a phosphate residual in the blowdown of up to 10 parts per million. Periodic sulfuric acid treatment will be used for descaling. The required dosages and the resulting sulfuric acid concentrations in blowdown are unknown at present. The effects of these blowdown constituents on aquatic organisms are evaluated in the discussion of aquatic ecology.

Low chlorine concentrations have been shown to produce adverse effects on phytoplankton (Carpenter, et al., 1972; Toetz, et al., 1977). However, the effects may be temporary with full recovery of the phytoplankton (Hirayama and Hirano, 1970; Goldman and Davidson, 1977). The dilution of chlorine in the 2.5-kilometer (1.5-mile) discharge canal should minimize the impacts of residual chlorine on aquatic ecosystems from Units 4 and 5. It is difficult to predict, however, whether there will be synergistic effects on indigenous fish species resulting from the addition of Units 4 and 5 to the existing influences of Crystal River Units 1, 2, and 3.

If organic phosphate scale inhibitor is used, it may generate a maximum phosphate residual in the blowdown of 10 parts per million. The total phosphorus content, however, will be diluted in the discharge canal and should have negligible impact on aquatic ecosystems.

The Crystal River Units 4 and 5 blowdown temperatures will be greater than the discharge canal water temperature during the months of October through April for all scenarios. Blowdown temperature will be lower during the summer months of May through September for all scenarios except Number 5. As indicated in Table 5.2.2, the cooling towers return less heat to the discharge canal as blowdown than they remove as make-up water during July, August, and September for all scenarios. Thus, during the hottest months, the cooling towers will mitigate the thermal impact of existing discharges from Crystal River Units 1, 2, and 3. In January and February, when water in the discharge canal is less warm, the cooling towers will return slightly more thermal energy than they extract.

The cooling tower discharge will cause an increase in temperature at the bulkhead line in January for all scenarios, and a decrease in July for all scenarios except Number 5. The worst-case temperature increase is 10.5°F winter and 3.7°F summer for scenario 5 (when Crystal River Units 1 and 2 have been decommissioned and Crystal River Unit 3 is on

temporary shutdown). Temperature increases of 1.0°F or greater occur in the winter for scenarios 1, 3, 5, and 6. The temperature actually decreases for all scenarios (except Number 5) in the summer. This analysis indicates that thermal impacts under steady state operating conditions will be insignificant. Thermal impacts could be significant, however, during unit start-up or shutdown. The cooling tower blowdown stream may be discontinued or started almost instantaneously. The transient thermal impact is difficult to assess quantitatively. Temperature changes might be rapid enough to stun or shock motile aquatic organisms.

5.2.3 BOILER BLOWDOWN

Blowdown and leakage from the steam-condensate-feedwater cycle will contain low concentrations of phosphorus, iron, copper, calcium, sodium, and possibly other residuals from the chemical feed (hydrazine, ammonia, trisodium phosphate). When discharged entirely to the plant drains collection pond, boiler blowdown and leakage would constitute more than 40 percent of the average inflow to the pond. Boiler blowdown and leakage will account for approximately 2 percent and 98 percent respectively of the total inflow into the pond from steam-condensate-feedwater cycle losses.

5.2.4 STORMWATER DISCHARGES

Overflow from the Runoff Collection Retention System may occur as a result of a quantity of water exceeding the design capacity, i.e., the 10-year, 24-hour storm event. This system accepts all surface runoff from the general site area and from roof drains, as well as incident rain plus overflow from the Ash Disposal Area and the New Coal Storage Area for events exceeding the design criteria of these holding areas, i.e., the 10-year, 24-hour storm event. Thus, discharge from the retention canal system introduces potentially harmful wastewaters into the offsite environment. For a listing of pollutants, see Chapter 3 and the discussion of groundwater pollution in the next section.

The potential impacts of overflows upon aquatic ecosystems will be limited greatly by three factors: (1) the low frequency of occurrence, (2) the short duration of overflows, and (3) the large quantities of dilution water available from existing Units 1, 2, and 3 when overflow events occur. One consequence of dilution is that wastewaters other than rainfall runoff will assume very small significance in the overall effluent. The contaminated runoff from rainfall in excess of the 10-year, 24-hour storm from areas such as the coal pile and ash storage facilities will in turn be diluted by good-quality runoff from other areas of the plant site, and by the flow in the discharge canal. Also, the runoff collection and retention system will provide a limited degree of treatment in the form of temporary detention storage even while overflows are occurring.

Given these factors, it appears unlikely that overflows due to storm events will constitute a significant source of ecological impacts. (This evaluation might be quite different, however, if overflows were directed to marsh areas rather than to the discharge canal.) In

FPCR4/5-TSD5.1/R5-2.9
6/27/80

particular, there appears to be little opportunity for synergistic effects involving stormwater-induced overflows from Units 4 and 5 and pollutant loadings from Crystal River Units 1, 2, and 3.

5.2.5 POTENTIAL LEACHATE CONTAMINATION

It is possible that leachate from the ash storage area, coal piles, plant drains collection pond, and/or canal retention system could affect the quality of surface water in the vicinity of the plant site. Hydrological and chemical characteristics of the site will tend to mitigate the impacts. These characteristics are discussed in detail in Section 5.3. Section 6.2.3 details the Leachate Testing and Monitoring Program in which leachate generation and attenuation will be studied. This program is required by the State of Florida Site Certification Conditions and by the NPDES permit.

5.2.6 COOLING SYSTEM INTAKE

The cooling tower intake structures are designed to maintain velocities through the intake screen of less than 0.15 meters per second (0.5 fps) during peak operation and 0.10 meters per second (0.18 fps) during normal operation in a quiescent water body. The mean cross-sectional velocity in the discharge canal at Units 4 and 5 intake structures at peak operating conditions for Units 1, 2, and 3 is 0.42 meters per second (1.4 fps). This maximum velocity will be lower for other operating conditions for Units 1, 2, 3, 4, and 5.

Potential flow analysis was utilized to evaluate entrainment and impingement potential at Units 4 and 5 intake screens for alternative operating conditions listed below. The potential flow results indicate that the water entrained by Units 4 and 5 intake flow field primarily flows through Unit 3, and will intake less than 10 percent of the cross-sectional volume of the discharge canal up to that point. Several operating scenarios were examined:

<u>Scenario</u>	<u>Units 1 and 2</u>	<u>Unit 3</u>	<u>Units 4 and 5</u>
1	Peak	Peak	Peak
2	Peak	Peak	Normal
3	Temp. Shutdown	Temp. Shutdown	Peak
4	Temp. Shutdown	Temp. Shutdown	Normal
5	Peak	Temp. Shutdown	Peak
6	Peak	Temp. Shutdown	Normal
7	Shutdown	Peak	Peak
8	Shutdown	Temp. Shutdown	Normal
9	No Discharge	No Discharge	Peak
10	No Discharge	No Discharge	Normal

The potential flow analysis demonstrates that the flow through Crystal River Unit 3 dominates the flow field in the discharge canal. A circulation problem could develop if Crystal River Units 1 and 2 are no longer operational and Crystal River Unit 3 is on temporary shutdown.

A circulation cell could form in the discharge canal between Crystal River Units 4 and 5 intake and discharge structures. The net direction of flow in the discharge canal would be reversed as water would flow in from the Gulf to supply makeup needs. This flow would result in severe thermal and salinity problems for cooling tower operation. Elevated temperatures and salinities could also cause severe ecological impacts. Florida Power will operate the circulation pumps of the units as required to reduce the potential for this problem.

5.3

IMPACTS ON GROUNDWATER SYSTEMS

5.3.1 INTRODUCTION

PUMPAGE

Florida Power Corporation proposes to obtain fresh water for Crystal River Units 4 and 5 from a well field about 8.2 kilometers (5 miles) east of the plant site (see Figure 5.3-1). The original tentative design of the well field was in the form of an east/west line along the northern boundary of section 32, township 17S, range 17E. The west well would be located on the Florida Power transmission line right-of-way about 300 meters (1,000 feet) east of the northwest corner of section 32. The 21 wells would be spaced approximately 150 meters (500 feet) apart.

Test drilling to date has shown the initial seven wells to have much higher transmissivities than used in the original tentative designs. Results from these tests indicate that four of the seven wells are adequate to supply the plant service water. Figure 5.3-2 identifies the locations of the supply wells. Specific capacity data from the seven production wells was presented to Florida Power Corporation on October 15, 1979, in a report by Geraghty and Miller, Inc., titled, "Hydrogeologic Report on Florida Power Corporation's Proposed Wellfield to Supply Water to Units 4 and 5 at Crystal River, Florida." The original plan for 21 wells was based on a very conservative estimate of the transmissivity of the planned wells. Water levels in the well field will be monitored under FDER Conditions of Certification.

The wells will be drawing water from the Floridan Aquifer. Maximum pumpage from the well field will be about 7,950 liters per minute (2,100 gallons per minute, or 3 million gallons per day). Average pumpage per

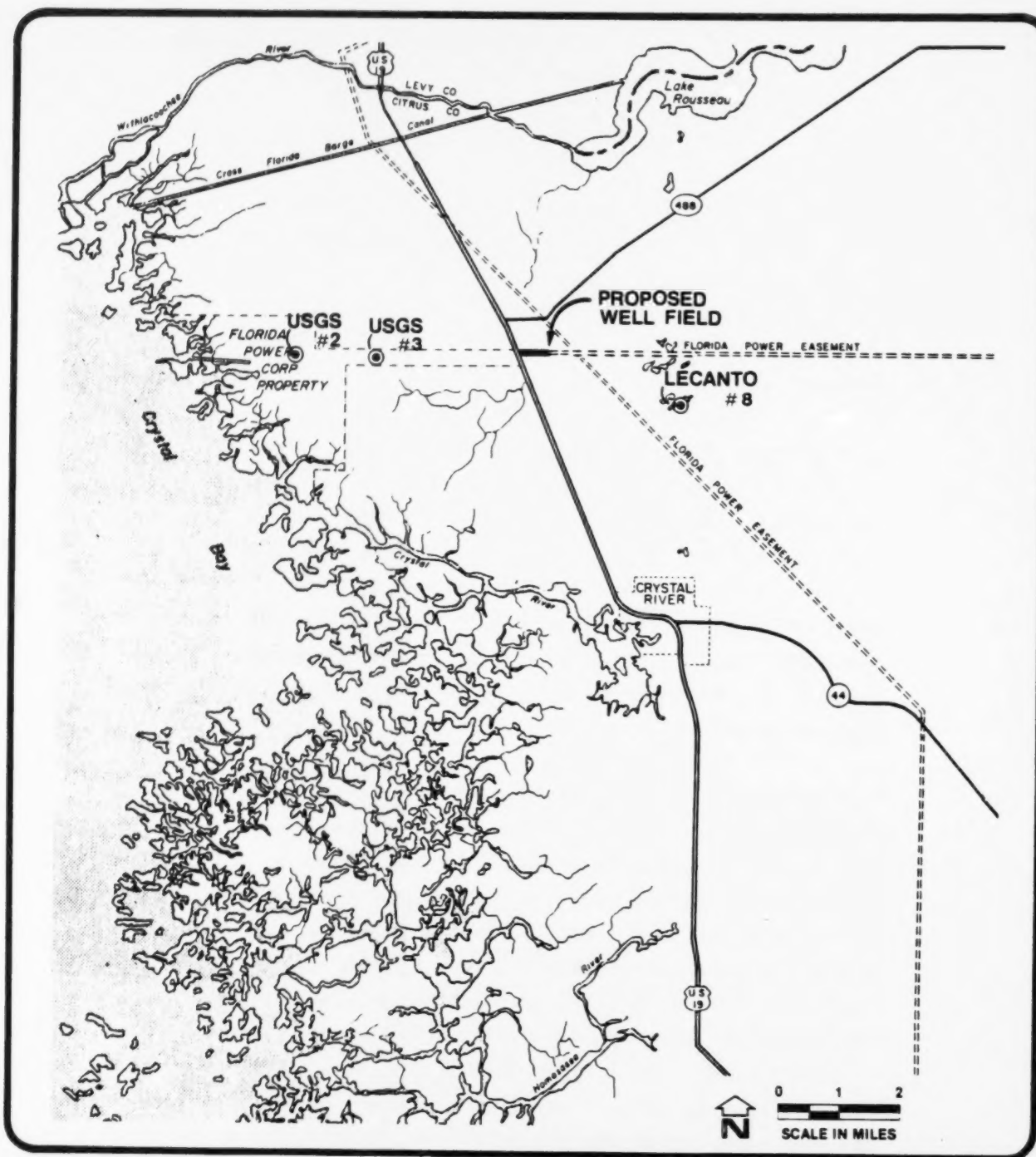


Figure 5.3-1

LOCATION OF PROPOSED WELL FIELD AND USGS OBSERVATION WELLS

SOURCE: Geraghty and Miller, Inc., 1980
Environmental Science and Engineering, Inc., 1980

FLORIDA POWER CORPORATION

**PROPOSED
CRYSTAL RIVER UNITS 4 & 5**

CITRUS COUNTY, FLORIDA

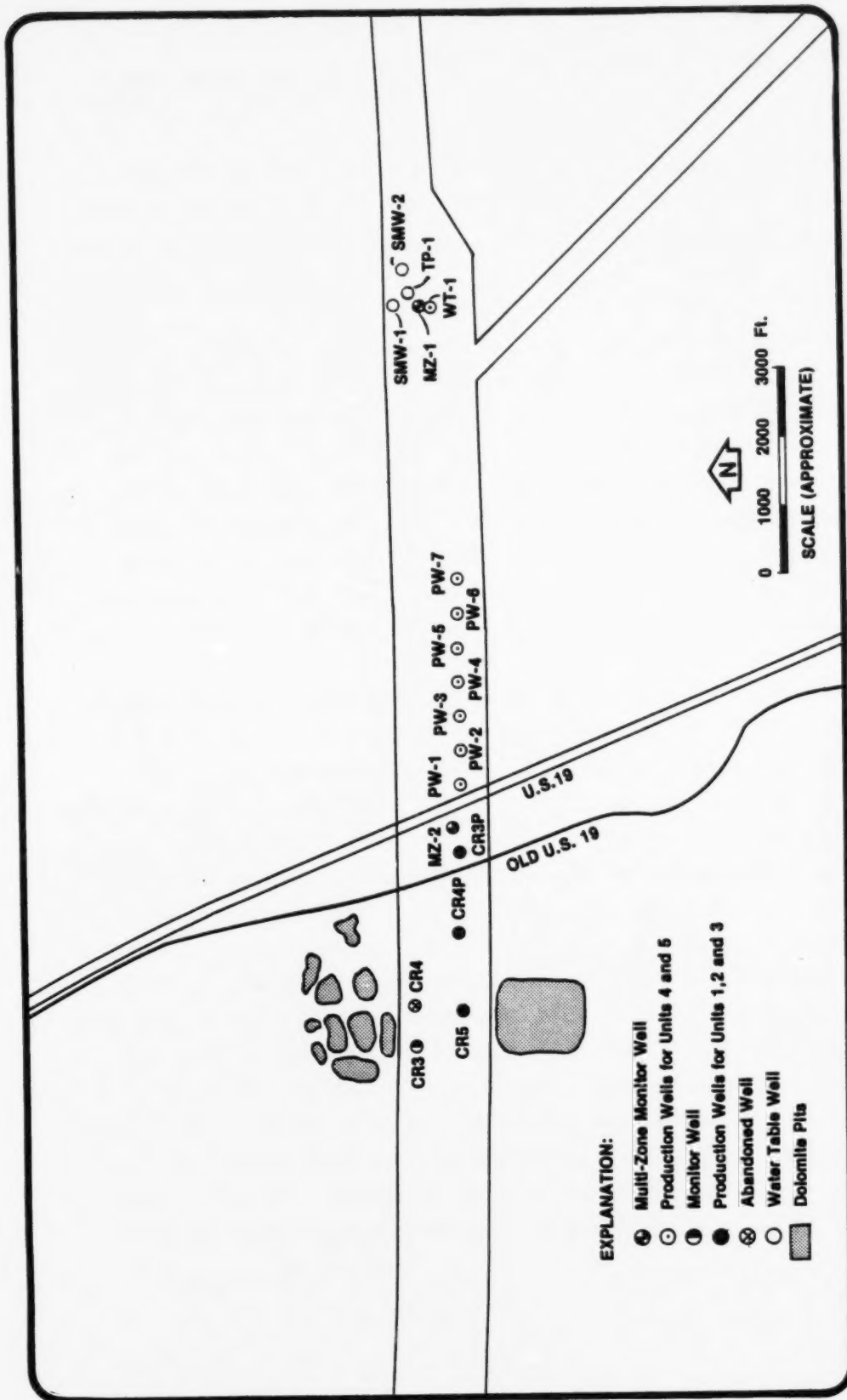


Figure 5.3-2

MAP SHOWING LOCATIONS OF EXISTING WELLS FOR CRYSTAL RIVER UNITS 1, 2 & 3, AND RECENTLY INSTALLED WELLS FOR UNITS 4 & 5

SOURCE: Garaghty and Miller, 1979

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

well will be approximately 1,987 liters per minute (525 gallons per minute or 0.76 million gallons per day). The Floridan Aquifer in this area is a cavernous limestone at the surface which acts as an unconfined water table aquifer.

Hydrologic coefficients were initially determined by a pump test near the plant site in order to assess the impacts of the proposed well field on the aquifer system. The average transmissivity was determined to be about 1,000,000 liters per day per meter (80,530 gallons per day per foot). Hydrologic coefficients were determined by pump tests in the proposed well field area in the fall of 1979. The average transmissivity was determined to be over 12,400,000 liters per day per meter (1,000,000 gallons per day per foot). The coefficient of storage was determined to be approximately 0.05 (Geraghty and Miller, 1979).

A flow net analysis performed prior to the pump test determined that the transmissivity of the aquifer system should be in the range of 1.86×10^8 liters per day per meter (1.5×10^7 gallons per day per foot) (Geraghty and Miller, 1977). The result approximates the conditions documented in the October 1979 Geraghty and Miller report. The discrepancy between the two transmissivity values is due to applying a method based on potential flow theory to a heterogeneous and non-potential flow aquifer system. The flow net analysis gives an average transmissivity value which is based on the total groundwater flow to the Crystal River. Much of the groundwater flow may take place through open solution channels or other zones of very high permeability which are adjacent to low permeability zones. The hydrogeologic system for a proposed well field site can only be defined by a test drilling program; the variation in transmissivity is not apparent from analysis of the regional flow characteristics. If solution channels are encountered in the well field, then the transmissivity will be much higher locally.

Based on the aquifer test data, the well field will require only four wells, each yielding 1,987 liters per minute (525 gallons per minute) to provide the required 11 million liters per day (3 million gallons per day) maximum for plant use without exceeding the SWFWMD (Chapter 16J F.A.C.) rules and regulations.

LEACHATE

The term "leachate" refers to rainwater, surface water, and/or ground water that picks up soluble parts from solids as it moves through solid waste. The solid waste may be buried or located on the land surface. Leachate is also referred to as "material storage runoff."

Solids deposited on the site will include coal from the coal storage area and the various waste products to be stored in the ash storage area from the burning of coal in the units. These various waste products include dewatered bottom ash, pulverizer rejects, economizer ash, pretreatment system sludge, and dry precipitator fly ash.

Leachate includes coal pile runoff and groundwater contamination from the above-mentioned solids on the site.

An understanding of leachate's characteristics and movement involves a complex set of interrelated variables. The following list points out most of these variables:

1. Chemical characteristics of water prior to contact with solids;
2. Chemical characteristics of solids;
3. Chemical characteristics of waters receiving leachate;
4. Characteristics of unconsolidated material (soils) below storage areas;
5. Characteristics of consolidated material (rock) below storage areas;
6. Characteristics of diked areas;
7. Characteristics of storage area bottoms;

8. Characteristics of surface water management system;
9. Soil adsorption properties;
10. Ultimate water table conditions within storage areas;
11. Length of time the water is in contact with solids;
12. Ultimate water level conditions outside storage areas; and
13. Engineering practices utilized to keep water away from solid materials.

The following studies/investigations were performed in the effort to address the leachate question:

1. A study of soils and rock data from site borings;
2. A study of existing surface and groundwater flow systems;
3. A study of the pertinent literature on leachate characteristics at other plants that might help predict on-site conditions;
4. A study of plant coal characteristics;
5. A study of plant engineering design concepts for storage areas and adjacent surface water management facilities; and
6. An investigation of limited water quality at existing coal and ash storage areas.

In addition to these previous studies, the Leachate Testing and Monitoring Program described in Chapter 6.2.3 will provide specific data on leachate characteristics and attenuation.

SUMMARY OF MATERIAL STORAGE SYSTEMS

Solid wastes to be stored in the ash storage area will be transported by truck or conveyor. The total storage development will consist of approximately 38 hectares (95 acres). The storage area will be developed in 8-acre (20-acre) segments, each of which will be filled to a height of 12 meters (40 feet) above existing grade. When the segment is developed to design height, the top surface will be sloped to drain and dressed with soil materials. The storage pile slopes will be dressed with soil material of sufficient depth to support vegetation. The soil material used for cover will be stockpiled in unused portions of the

ash storage area. A toe canal will be constructed along the perimeter of the active storage segment to receive surface stormwater runoff. The stormwater runoff in excess of the 10-year, 24-hour storm event will be discharged to the runoff collection and retention system. The on-site ash storage area will be sufficient for the storage of all bottom ash, pulverizer rejects, economizer ash, pretreatment system sludge, and precipitator fly ash produced during 24 years of the 30-year project life of Units 4 and 5. This conclusion is based on the average generation capacity with the proposed fuel supply.

Because fly ash from these units will be handled dry, it may be sold for such uses as: mineral filler in asphalt paving, additive in concrete and concrete products, Pozzolan in soil stabilization, raw material in light-weight aggregate, grouting agent, fill for development, and agricultural applications. If 26.5 percent of fly ash from Units 4 and 5 is sold, the on-site storage area will be sufficient for the storage of all ash and pretreatment system sludge for 30 years of operating life at average capacity.

The ash will be spread in 18-inch lifts by motor graders and track-type dozers. The ash will be wetted by water from a tank truck and compacted by a rubber tire or vibrating roller compactor. The maximum density anticipated is between 85 and 110 pounds per cubic foot. The actual maximum density and optimum moisture must be determined in the field after sufficient ash is available to initiate a testing program.

The permeability of compacted ash varies with the type of ash and the degree of compaction. Compacted bottom ash and pulverizer rejects are relatively permeable, with permeability rates on the order of 1×10^{-4} to 1×10^{-5} centimeters per second, similar to those of fine sand or sandy silts. Compacted fly ash is relatively impermeable, with a rate of approximately 1×10^{-6} centimeters per second or less. Rates of 1×10^{-6} centimeters per second or less are generally considered satisfactory for use as pond and reservoir liners. The combination of the coarse bottom

ash, rejects, and the fine fly ash will result in a poorly sorted material with a permeability in the range of 1×10^{-5} to 1×10^{-6} centimeters per second.

The new coal storage area includes 47 acres of active and inactive storage areas. The active storage area covers 27.5 acres, and the inactive storage area covers 20 acres. The areas will be diked and drained by a 3-acre perimeter drainage ditch. The storage areas will not be lined.

A runoff collection and retention system provides surface water control for the area. This system will collect all runoff from the material storage areas and meter it out to the existing discharge canal as shown in Figure 3.10-3. The coal and ash storage areas will have controlled outlets that will meter discharge to the runoff collection and retention system. According to the engineering design concept, no discharge will occur throughout these areas unless the rainfall exceeds the 10-year, 24-hour storm.

All discharges from these areas will also pass through an oil skimmer. The swale-runoff type collection ditch system cuts across the north and west sides of the ash storage area.

SUMMARY OF NATURAL SYSTEM FEATURES

The overburden soils at the ash and coal yard consist of very loose to medium-dense organic material, sand, and silt. The thickness of the overburden varies from less than .6 meter (2 feet) to 3.0 meters (10 feet). The permeability of these overburden soils varies depending on the type of material and compaction. Generally, the sand and silt material have a permeability of approximately 1×10^{-4} to 1×10^{-5} centimeters per second. Pockets of fine material such as silts and clays would have a permeability of 1×10^{-6} centimeters per second or less.

The underlying Inglis limestone is jointed and highly variable in consistency and contains numerous voids attributable to solutioning and weathering. The voids are either water-filled or filled with sand, silt, or clay to some degree. The remaining formations beneath the Inglis limestone include an unconsolidated zone, characterized by a few centimeters (inches) to a few meters (feet) of residual soil or water-filled cavity, and the Avon Park formation. The latter is a dolomite unit which has undergone minor solutioning and has fewer voids and higher strength than the Inglis formation. The permeabilities of the underlying Inglis limestone are highly variable, depending on solution and dolomitization features. A zone with major solution features would have a permeability of approximately 5×10^{-2} centimeters per second.

Ground water occurs in the ash and coal yard area at or near elevation 28 meters [92 feet (plant datum); the Mean Low Water Level for the Gulf of Mexico is roughly 88 feet (plant datum)]. The water table ranges in depth from approximately 0.4 meter (1.2 feet) to 1.1 meters (3.7 feet) below the existing ground surface. However, in localized areas the presence of standing water indicates a perched water table condition above the organic soil layer.

Wastewaters percolating into the soil at the proposed plant site would tend to flow west and south toward the Gulf of Mexico. Typical chemical characteristics of fresh ground water at the site are included in Table 3.3-2.

5.3.2 PHYSICAL EFFECTS OF GROUNDWATER WITHDRAWAL

The cone of depression from pumping at the well field has been computed in order to estimate the effect of groundwater withdrawal on the potentiometric surface of the upper Floridan Aquifer. The potentiometric map utilized to describe baseline conditions is the map prepared by the U.S. Geological Survey for May 1975.

The potentiometric surface map is illustrated in Figure 5.3-3. The 0.3-meter (1-foot) contours have been estimated from the 5- and 10-foot contours shown on the USGS potentiometric map for May 1975, and from water levels in USGS observation wells in the area.

The water surface elevation in the upper part of the Floridan Aquifer in the vicinity of the proposed well field fluctuates between 1.2 and 2.7 meters (4 and 9 feet) above mean sea level.

It should be emphasized that in the following discussion of groundwater withdrawal impacts, drawdowns were computed using assumptions of Darcian flow, and solutions to boundary value problems were computed using the diffusion equation. The near-surface cavernous limestone does not conform to the assumptions necessary for Darcian flow. Application of standard pump test solutions to this flow regime provides an order of magnitude approximation of transmissivity.

The following assumptions were made in the calculations:

1. The water-bearing formation is isotropic (homogeneous);
2. The water-bearing formation has a uniform thickness;
3. The water-bearing formation has an infinite areal extent;
4. No recharge occurs during pumping;
5. The wells penetrate and receive water from the full thickness of the aquifer;
6. Water is removed from storage instantaneously; and
7. Darcian flow.

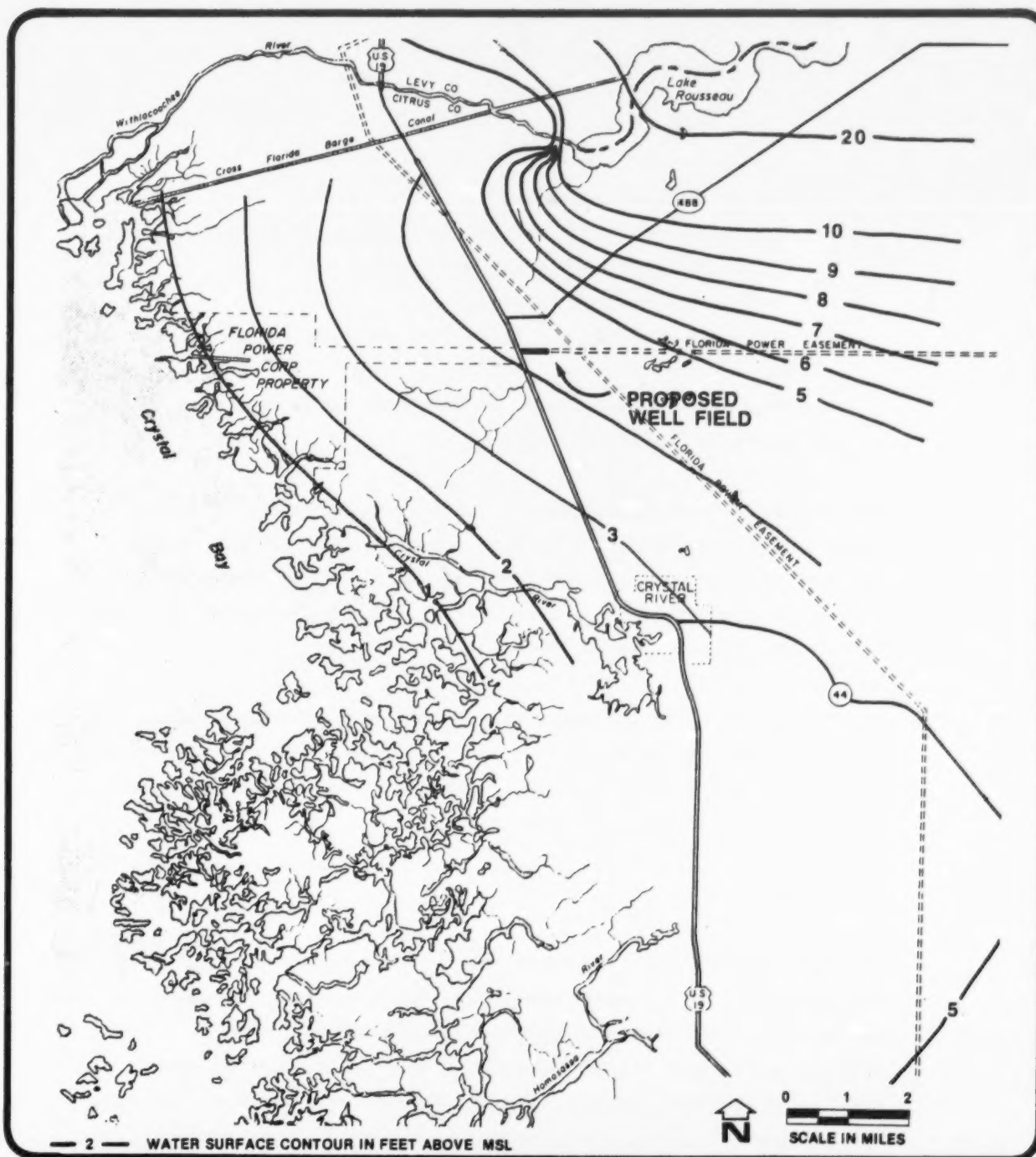


Figure 5.3-3

**POTENTIOMETRIC SURFACE OF UPPER FLORIDAN
AQUIFER, MAY 1975**

SOURCE: Geraghty and Miller, Inc., 1980
Environmental Science and Engineering, Inc., 1980

FLORIDA POWER CORPORATION

**PROPOSED
CRYSTAL RIVER UNITS 4 & 5**

CITRUS COUNTY, FLORIDA

Values used in the computations are:

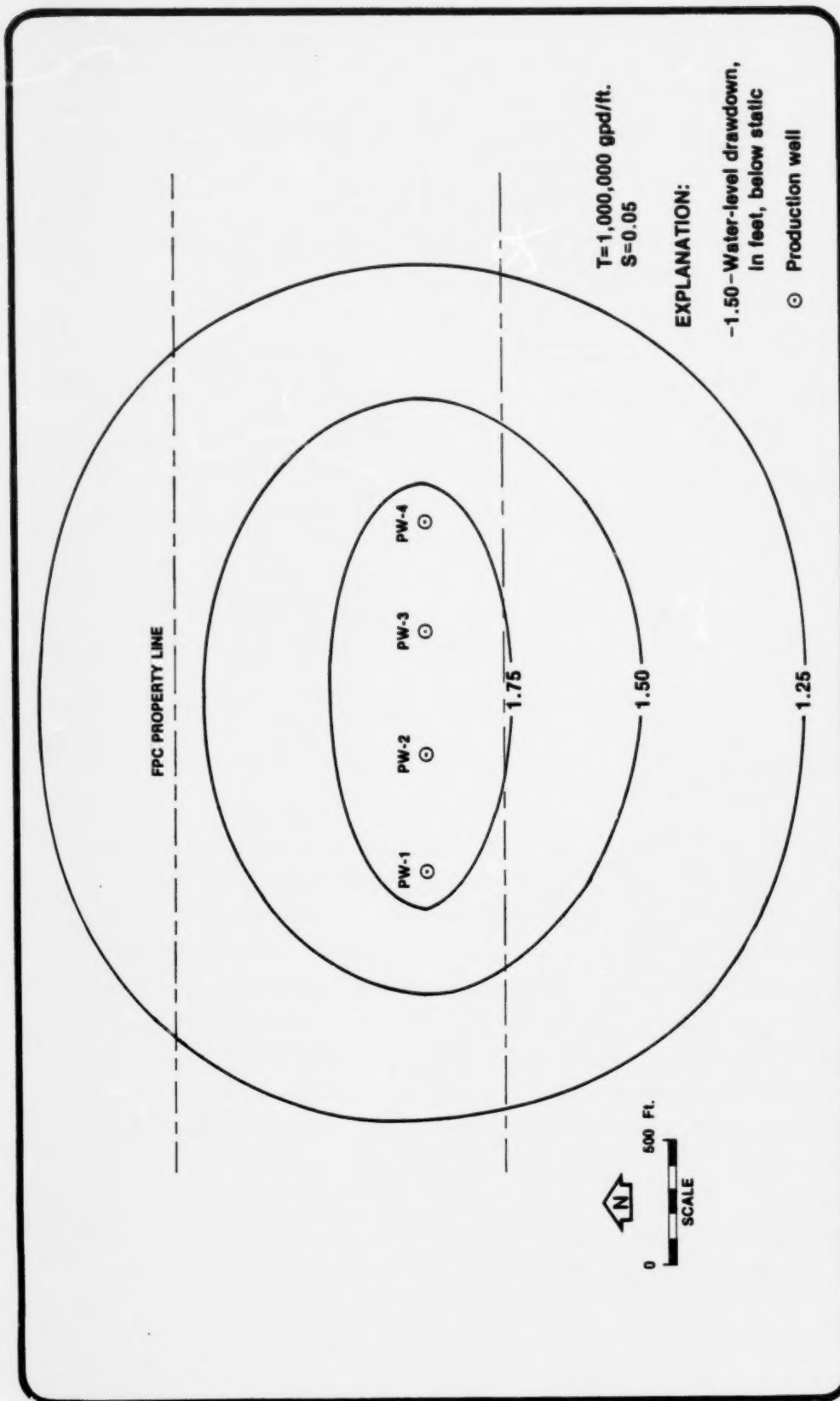
1. Transmissivity (T) = 3.8 million liters per day per meter (1,000,000 gallons per day per foot);
2. Storage coefficient (s) = 0.05;
3. Discharge rate (Q) = 1,987 liters per minute (525 gallons per minute) for each well; and
4. Drawdowns are calculated for a period of 90 days without recharge (rainfall).

The calculated cone of depression for a maximum pumpage of 3 mgd for Wells PW-1, PW-2, PW-3, and PW-4 is shown in Figure 5-3.4. Expected maximum water level drawdowns for these wells, at the FPC property line (900 meters, 330 feet), is approximately 1.75 feet (based on Geraghty and Miller report, October 1979).

During periods of normal usage the groundwater yield from the well field will be reduced to about 1,518 liters per minute (401 gallons per minute or 0.58 million gallons per day). The cone of depression will be reduced proportionately in areal extent.

WATER QUALITY

Geologic, geophysical, and water quality data from the aquifer test at the well field site suggest that rock layers beneath the productive zone in the well field form a protective low permeability zone which will inhibit upconing of highly mineralized water (Geraghty and Miller, 1978). If fracture systems exist in the area and extend through this low permeability zone, then conditions of high vertical permeability, (which will allow upward movement of highly mineralized water) may occur locally. However, a situation where fracture systems extend through the low permeability zone would probably affect only individual wells rather than the entire well field. Good well field management can minimize any water quality deterioration from this source. The well monitoring



FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Figure 5.3-4
PREDICTED DRAWDOWN OF WATER LEVELS AFTER PUMPING WELLS PW-1,
PW-2, PW-3, & PW-4 FOR A TOTAL OF 3mgd FOR 80 DAYS WITH NO RAIN.

SOURCE: Geraghty and Miller, 1979

program required under the Conditions of Certification will provide data on water level and quality.

As specified in the FDER Conditions of Certification, well monitoring will be conducted as follows:

<u>Wells</u>	<u>Parameter</u>	<u>Frequency/Timetable</u>
SMW-1, M21, WT-1	Water Level	Continuous recorder/Begin at least one year prior to operation of CR4; submit results quarterly
MZ-1, MZ-2	Ca ²⁺ , Mg ²⁺ , K ⁺ , Na ⁺ , HCO ₃ ⁻ , NO ₃ ⁻ , Cl ⁻ , SO ₄ ⁻² , TDS, Tot-P, specific conductance, gross Alpha, and Radium 226 (if gross Alpha >15 pci/l)	Monthly/During first year of operation; at the beginning of each quarter during the second year; twice yearly (May and September) each year thereafter

Source: FDER Conditions of Certification, September 15, 1978.

EFFECTS ON SURFACE WATER

Surface waters in the area consist of karst-type depressions and scattered small wet areas. As noted in Chapter 2, there is a conspicuous absence of defined stream channels in the area. Cherry (1970) reports that between 55 and 75 percent of the annual rainfall in the area is returned to the atmosphere via evaporation. The remainder percolates through the thin sands and recharges the Floridan Aquifer; thus, there is virtually no surface runoff in the well field area. The water surface in the ponds and lakes in the area is probably at approximately the same level or slightly above the water level surface in the Floridan Aquifer.

Potential water level declines in surface water bodies will be confined to areas in and immediately adjacent to the Florida Power Corporation

well field. The impacts are difficult to assess since nothing is known about the presence or absence of clays or other poor permeability zones directly beneath the surface water bodies in question. In the absence of clays or poor permeable materials, the surface water bodies will respond to well field pumpage.

EFFECT ON GROUNDWATER AVAILABILITY

The groundwater availability analysis compares the proposed withdrawals from the aquifer system with the estimated groundwater flow to the Gulf through Crystal River and the area containing the well field and plant site.

The U.S. Geologic Survey gaging station at Crystal River records an average of about 2,200 million liters per day (590 million gallons per day) of water flowing to the Gulf of Mexico. Geraghty and Miller (1977) calculate that another 950 million liters per day (250 million gallons per day) of water flows to the Gulf in the area north of the gaging station at Crystal River (excluding the flow at the Crystal River gage) and south of the Withlacoochee River (excluding the flow to the Withlacoochee). The projected maximum well field demand is less than 1 percent of the flow at Crystal River and about 1 percent of the estimated flow between the Crystal and Withlacoochee Rivers. The annual average water usage is less than one-fifth of the design maximum flow of the well field.

5.3.3 BIOLOGICAL EFFECTS OF GROUNDWATER WITHDRAWAL

The possible biological effects of groundwater withdrawal could primarily involve the biological communities associated with freshwater marshes. As discussed in the previous section, these freshwater areas may be connected with ground water and may experience changes in water level due to withdrawals.

Impacts of well field groundwater withdrawal on vegetation and wildlife should not be significant. Impacts could result from surface water table lowering and consequent drainage of temporary or permanent wetlands. Estimates of these water level changes are based on the calculations in Section 5.3.1. The seasonal fluctuations of three nearby wells (reported by Geraghty and Miller, 1977) and their relation to land surface elevation have also been considered. The analysis has indicated that wet season water tables may be altered only above the land surface in depressed wetland areas. This would most likely occur within one mile south and west of the well field site. Few significant wetlands of this type occur within this distance from the well field, and no significant effects on any biological communities are expected. Some possible seasonal changes in species composition and pattern may occur, but withdrawals from the aquifer should not lower the water table sufficiently to permanently alter the character of these marshes.

The cypress domes north of the well field should not be affected. Since the land surface elevation is about 6 to 8 meters (20 to 25 feet) and the water table about 3 to 5 meters (10 to 15 feet), the cypress domes are probably perched upon impervious confining layers and unaffected by changes in water table elevation.

Effects on wildlife would be proportional to effects on surface waters. With expected amounts of surface drawdown, no significant effects on wildlife are expected.

5.3.4 COAL AND ASH STORAGE LEACHATE

Florida Power Corporation will select coal from a combination of far western United States and Appalachian coal fields to comply with EPA air regulations. Table 5.3-1 shows the range in typical characteristics of the coal and ash from eight possible mines. Table 5.3-2 shows general comparison of eastern and western coals.

Literature is available on chemical characteristics of heavy metals from fly ash and bottom ash from the Pennsylvania coal region. Table 5.3-3 shows representative characteristics.

Rainfall percolating through coal piles tends to become contaminated by leaching out the oxidation products of metallic sulfides. Decomposition of the sulfide-containing minerals results in high concentrations of acidity, which in turn stimulates oxidation and furthers acid production. Runoff samples from coal piles studies by Nichols (1974), Anderson (1976), and Cox and Ruane (1967) have been found to contain elevated concentrations of acidity (as CaCO_3), suspended solids, total dissolved solids, iron and manganese, and a variety of trace metals. The findings of the Cox and Ruane study are considered here in order to illustrate the characteristics of coal pile runoff/leachate. The data can only provide a general indication of conditions at Crystal River Units 4 and 5, however, since the coal supplies for these units are presently indefinite and are likely to differ in significant respects from the coals studies by Cox and Ruane.

The Leachate Testing and Monitoring Program detailed in Chapter 6.2.3 will investigate the characteristics and attenuation of leachate.

Table 5.3-4 summarizes the runoff water quality for two eastern coals. The observed pH values ranged from 2.2 to 3.1, and the acidity levels (concentrations as CaCO_3 in milligrams per liter) varied between

Table 5.3-1 Alternative Florida Power Corporation Coal Sources

Coal Analysis	Range in Typical Characteristics (Percent by Weight)
Moisture	7 - 30.0
Volatile Matter	30 - 39.8
Fixed Carbon	32.1 - 51.0
Ash	5.8 - 16.4
Carbon	48.5 - 77.0
Hydrogen	3.4 - 5.1
Nitrogen	0.7 - 1.4
Sulfur	0.4 - 4.2
Chlorine	0.01 - 0.18
Oxygen	5.02 - 12.78
Ash Analysis	
P ₂ O ₅	0.1 - 2.0
SiO ₂	34.0 - 53.6
Fe ₂ O ₃	4.0 - 26.6
Al ₂ O ₃	13.0 - 35.4
TiO ₂	0.5 - 1.3
CaO	0.9 - 20.0
MgO	0.8 - 6.0
K ₂ O	0.4 - 2.60
Na ₂ O	0.2 - 4.5
SO ₃	0.04 - 13.7

Source: Black and Veatch, 1978.

Table 5.3-2 Percent Composition Comparison of Eastern and Western Coals

Component	Coal Source	
	East (Percent by Weight)	West
Carbon	67.22	48.50
Hydrogen	4.12	3.40
Sulfur	2.28	0.50
Oxygen	2.72	11.10
Nitrogen	1.16	0.70
Moisture	4.10	27.80
Ash	<u>18.40</u>	<u>8.00</u>
Total	100.00	100.00

Source: Second National Conference on Complete Water-use, 1975.

Table 5.3-3 Heavy Metal Concentration of Fly Ash and Bottom Ash

Metal Element	Fly Ash (ppm)	Bottom Ash (ppm)
Arsenic	8 - 120	2 - 250
Cadmium	.01 - 8	.01 - 15
Cesium	100 - 8,000	15 - 800
Cobalt	7 - 90	20 - 80
Chromium	90 - 120	80 - 150
Copper	90 - 150	.01 - 300
Mercury	0.7 - .15	1 - 2
Magnesium	110 - 150	150 - 200
Sodium	1200 - 12,000	2,000 - 8,000
Nickel	110 - 150	150 - 150
Lead	110 - 150	150 - 250
Tin	.01 - 15	2 - 15
Selenium	25 - 75	3 - 10
Titanium	9,000 - 20,000	5,000 - 15,000
Vanadium	115 - 150	100 - 300

Source: Proceedings of the Fourth Annual Environmental Engineering and Science Conference, University of Louisville, 1974.

Table 5.3-4 Chemical Characteristics of Coalpile Runoff

Plant		pH	Acidity (mg/l CaCO ₃)	Sulfate (mg/l)	Dissolved Solids (mg/l)	Suspended Solids (mg/l)	Fe (mg/l)	Mn (mg/l)
J	Range	2.3-3.1	300-7100	1800-9600	2500-16000	8.0-2300	240-1800	8.9-45
	Mean	2.79	3400	5160	7900	470	940	28.7
	N	19	18	18	18	18	19	19
E	Range	2.5-3.1	860-2100	1900-4000	2900-5000	38-270	280-480	2.4-10.0
	Mean	2.67	1360	2780	3600	190	380	4.13
	N	6	6	6	6	6	6	6
E (Discrete Storm)	Range	2.5-2.7	300-1400	870-5500	1200-7500	69-2500	62-380	0.88-5.4
	Mean	2.63	710	2300	2700	650	150	2.3
	N	14	14	14	14	14	14	14

Source: Doye B. Cox and R. J. Ruane, TVA, 1967.

300 milligrams per liter and 7,100 milligrams per liter. Concentrations of suspended solids and dissolved solids were also high, the former due to the suspension of coal fines during rainfall events. Iron and manganese concentrations in the coal pile runoff were in excess of Florida state water quality criteria.

The concentrations of trace elements observed by Cox and Ruane are listed in Table 5.3-5. The cadmium, beryllium, and chromium levels shown are well below the established criteria and pose no threat to aquatic or human communities. The observed aluminum concentrations are high relative to natural waters, but their significance is questionable since aluminum is not covered by finalized criteria for toxic substances. The mercury concentrations exceed established water quality criteria, and selenium, arsenic, zinc, and copper concentrations are also above EPA-recommended levels.

Table 5.3-6 presents heavy metal concentrations from a southeastern coal. Heavy metal concentrations from clay, gypsum, and silica leachate are also listed as comparative references. The coal leachate contained the highest concentrations of the heavy metals analyzed except for lead. All of the other heavy metal concentrations exceeded the EPA water quality criteria.

Less than half of the exfiltration from the ash disposal area will result in direct ash leachate. At any given time, only 8 of the 38 hectares (20 of the 95 acres) dedicated to ash disposal will be active. Runoff from this area and inactive areas will be channeled to collection and retention canals within 38 hectares (95 acres) where exfiltration will occur. Compaction and sloping of ash lifts will maximize runoff and minimize direct ash area exfiltration.

The active ash storage area will tend to yield groundwater pollutants in roughly the same fashion as the new coal storage area. Up to 85 percent of ash from pulverized coal is fly ash (TVA/EPA, 1977). Fly ash tends

Table 5.3-5 Trace Metals in Coalpile Runoff

Plant	Cu	Zn	Cd mg/l	Al	Ni
J	Range	2.3-16	<.001-<.001	66.0-440	0.74-4.5
	Mean	6.68	<.001	260	2.59
	N _D	0	19	0	0
	N	19	19	19	19
E	Range	1.1-3.7	<.001-0.003	22.0-60.0	0.24-0.46
	Mean	2.18	0.002	43.3	0.33
	N _D	0	2	0	0
	N	6	6	6	6
	Cr	Hg	As mg/l	Se	Be
J	Range	<.0002-.0025	.005-0.6	<.001-.03	0.03-0.07
	Mean	.007	0.17	0.006	0.044
	N _D	11	0	4	0
	N	17	19	18	18
E	Range	0.003-.007	0.006-0.046	<.001-.001	<.01-0.03
	Mean	0.004	0.02	0.001	0.014
	N _D	3	0	3	3
	N	6	4	4	4

N_D = Number of samples below detection limits.

Source: Doye B. Cox and R.J. Ruane, TVA, 1967.

8/15/78

HTB5.3-6

Table 5.3-6 Concentrations of Heavy Metals from Material Leachates

Source of Leachate	Metal Concentrations (ug/l)						
	Cd	Cu	Fe	Pb	Mn	Hg	Ni
Coal	5.1	220	20,159	7.6	15,661	5.7	658
Clay	0.45	<1.0	266	6.2	<55	2.4	<2.0
Gypsum	0.71	2.6	266	23	<55	0.65	44
Silica	0.40	<1.0	2.89	1.7	<55	1.8	<2.0
							1,225
							<15
							40
							<15

Source: Environmental Science and Engineering, Inc., 1977.

to be of greater concern than bottom ash because of its greater volume and higher metals concentrations. Fly ash at a TVA coal-fired plant was found to be enriched by a factor of at least ten, relative to normal soil, in arsenic, copper, lead, and vanadium. Fly ash was also enriched to a lesser degree in cadmium, cobalt, chromium, cesium, europium, mercury, antimony, uranium, and zinc. Several elements are concentrated preferentially in fly ash, but only calcium is appreciably more concentrated in bottom ash (Lindberg, et al., 1975; Klein, et al., 1975). Table 5.3-7 shows the chemical properties of discharge from an existing partially completed ash disposal site in western Pennsylvania. The authors state that concentrations of sulfate, total dissolved solids, pH, and manganese did not meet existing water quality standards. Also, these authors did further lab studies to prove that ash leachate is generally alkaline. They state that some ashes may exhibit an acidic leachate in the early flushes.

Until the results of the Leachate Testing and Monitoring program have been interpreted, it will not be possible to predict which metals will be leached from stored ash. Some of the leached metals may form insoluble precipitates which are not carried from the site, and others may be adsorbed by soils and thus not widely distributed. For example, Wentink and Etzel (1974) found that columns of soil removed all copper, chromium, and 99.7 percent of zinc from combined solutions of up to 300 milligrams per liter of each metal in distilled or tap water. However, other studies indicate that adsorption may be incomplete and/or may depend on special factors. Jennett and Linnemann (1977) suggest that a soil will adsorb 100 percent of its cationic exchange capacity of metals if the metals are applied slowly over a long period of time. They also found that lead and zinc, once adsorbed, could not be removed by ordinary rainwater, but metals could be removed by strong chelating agents such as humic acids.

The ability of acids, metals, and sulfates from coal leachate to pass through the soil is indicated by the following data for coal mine

Table 5.3-7 Chemical Properties of Discharge from Existing Partially Completed Ash Disposal Site in Western Pennsylvania

Parameter	Range of Measured Values (mg/liter unless otherwise mentioned)
Chemical Oxygen Demand	23
Total Dissolved Solids	3,000-3,800
Iron (Total)	18-200
Manganese	15-19
Calcium	139-424
Magnesium	100-400
Ferrous Iron	0.5-4.0
Aluminum	12-33
Sulfate	1,200-1,800
Chloride	40-55
pH	2.9-3.7 units
Fluoride	0.5
Specific Conductance	2,100-5,500 umhos
Temperature	50°F

Source: "Water Quality Management - Power Station Coal Ashes," ASCE Power Division Specialty Conference, 1974.

drainage in the Toms Run Basin, Pennsylvania (from Merritt and Enrich, 1970).

	<u>Area</u>	<u>pH</u>	<u>Fe(ppm)</u>	<u>SO₄(ppm)</u>
Lower Aquifer:	non-mining	6.3-6.8	3-16	4-13
	mining	2.9-5.4	25-160	30-620
Upper Aquifer:	non-mining	6.5-6.7	10-15	10-15
	mining	3.0-3.5	20-70	39-80

Limestone soils found at the Crystal River site should increase the pH of percolating waters from coal piles, but not to sufficiently precipitate metals (Boyer and Gleason, 1977). The acidity of the coalpile runoff could aid transport through soil of metals that might be leached from the ash pile. Limestone may not provide adequate pH increase to prevent this occurrence. In summary, it is very difficult to predict the transport of pollutants into the ground water from the proposed coal and ash storage areas at Crystal River, but the loadings of metals and perhaps other contaminants may be substantial.

Regarding vegetative impacts, there is little information concerning the ecological effects of low pH and metals in soil and pore water on marsh vegetation. Lee, et al. (1976), hydroponically grew eight species of marsh plants in combined concentrations of 0.0, 0.5, or 1.0 ppm each of cadmium, chromium, nickel, lead, and zinc. Metals did not reduce growth except possibly for Scirpus validus and Spartina patens. Fly ash contains chromium, nickel, lead, and zinc in concentrations exceeding 1 ppm. However, the concentrations of these metals in ash pile leachate and runoff are not known.

Metal concentrations of 100 ppm can be toxic to Spartina alterniflora (Dunstan, et al., 1974 a.b., via Lee, et al., 1976). Copper killed seedlings in two weeks; zinc, mercury, lead, or methyl mercury killed 35 to 50 percent after eight weeks. Cadmium had no adverse effect after eight weeks.

Normal levels of heavy metals in soils may have wide ranges. Arsenic levels are usually less than 10 ppm and rarely above 70 ppm; copper levels are usually less than 60 ppm; lead averages about 15 ppm and seldom exceeds 50 ppm (Motto, et al., 1970; Taskey, 1970). Available or soluble levels may run about 10 percent of total levels (Taskey, 1970). Arsenic has been found toxic to citrus at soluble levels of 2 ppm (Liebig, et al., 1959), and it damages rice at 0.2 ppm in poorly drained soils (Epps and Sturgis, 1939). Arsenic also has greatest toxic effects in acid sandy soils (Arnott and Leaf, 1967). Copper has been shown to inhibit growth in solutions of 150 ppm to 250 ppm (Motto, et al., 1970), although lead concentrations in soil of 12 ppm to 680 ppm produced no consistent effects on bromegrass (Marten and Hammond, 1966). General effects of these heavy metals are reduced roots and short growth, general deformity, and thick, darkened roots. Germination may be affected with higher concentrations (Taskey, 1970). Jordan (1975) found that zinc-cadmium interactions caused greater damage to vegetation in Pennsylvania than did either zinc or cadmium alone. Seedling growth of red oak and aspens was reduced at zinc levels above 1 ppm and cadmium levels above 5 ppm.

Without further data on the transport of heavy metals into and through ground water, on the uptake or adsorption of metals by the soils found on-site, and on the resultant degree of accumulation in the root zone, it is not possible to make a meaningful assessment of the magnitude or significance of impacts at this time. However, a worst-case assumption might be a scenario in which the heavy metal concentrations throughout the groundwater system would be equal to those in coal pile runoff, so that zinc, nickel, copper, and possibly arsenic levels would be greater than 1 part per million in areas where salt marsh and coastal hydric hammock species occur. These levels, which have been reported to possibly cause reduced growth in trees and marsh species, might then result in reduced growth, community productivity, and detrital production.

Accumulation of heavy metals in soils, if reaching toxic levels, could lead to plant death, subsequent elimination of various floral components of the community, and a potential situation in which new seedlings could not become established. Thus, the functional nature of various areas of marsh or hammock could be destroyed. The salt marsh system probably would be more susceptible to large scale disruption because of its low species diversity.

Heavy metals could pass into faunal components through ingestion of detritus (detritivores), live vegetation (grasshoppers, etc.), or possibly through direct absorption in the marine system. Eventually, accumulation would occur in some fishes, birds, and other higher level carnivores.

Therefore, it appears that the levels of heavy metals in the ash products could damage vegetation if they are carried in the leachate, if concentrations down-gradient remain high, and if they enter the root zone. Whether these conditions will exist is unknown at this time. Impacts on existing vegetation may be negligible if the heavy metals remain at the lower portion of the root zone, rather than accumulating near the surface where younger, more sensitive plants are rooted.

Heavy metals concentration and soil acidity may hinder re-establishment of vegetation on the reclaimed ash storage areas. This effect should be overcome if a sufficiently thick overburden cap and adequate drainage are provided.

It is probable that any impacts from leachate formed from coal and ash storage and other wastewater streams will be confined to an area adjacent to the leachate source. As the leachate moves further through the strata, concentration will decrease to mitigate the impact.

5.3.5 LEACHATE IMPACTS AT CRYSTAL RIVER SITE

The characteristics and impacts of leachate will be assessed in a major Leachate Testing and Monitoring Program addressed in Chapter 6.2.3. Based on the previous data analyzed, however, the following conclusions seem pertinent for the Crystal River site:

1. Leachate may show up in surface and ground waters adjacent to the storage areas. The areal extent, contamination of parameters, and concentrations of heavy metals, if present, propose questions that cannot be confidently answered with the present knowledge.
2. The leachate movement beyond the storage areas will be slight at first, mainly because water gradients in the area will be low and the area involved will be small.
3. Leachate movement may be ultimately significant, when the water level within the storage areas rises to perhaps as high as 40 feet above the surrounding water levels, and the time of contact between water and solids is extended.
4. Leachate movement will probably be primarily to the west and south of the storage areas because of the natural flow pattern in the area; however, under certain conditions, leachate will probably move in all directions around the storage areas to some degree.
5. Runoff samples from coal piles studied by Nichols (1974), Anderson (1976), and Cox and Ruane (1967) have been found to contain elevated concentrations of acidity, suspended solids, total dissolved solids, iron and manganese, and a variety of trace metals. It is not definite at this time whether or not all these characteristics will exist at the Crystal River site.

3/25/80

6. TVA has documented that fly ash has elevated concentrations of metals, but gaps in present research make the prediction of leachate effects difficult. It is not known which metals will be leached from stored ash.
7. Some of the leached metals may form insoluble precipitates which are not carried from the site, and others may be adsorbed by soils and thus not widely distributed [Wentink and Etzel (1974)].
8. Other studies (Jennett and Linnemann, 1977), however, indicate that adsorption probably will not be complete.
9. The site soil and rock conditions encountered during construction and the final construction details of the storage area bottoms will, in large measure, determine the nature of future leachate movement.
10. Total dissolved solids of the leachate may not be significantly different from the receiving waters as documented in the limited water quality study conducted adjacent to the existing storage areas. The receiving waters in the area of the storage areas are typically brackish.
11. Leachate transport through solution channels beneath storage areas will be attenuated by mechanically sealing off any such channels as they are discovered during the geophysical phase of the Leachate Monitoring Program.
12. Some vegetation adjacent to the storage areas may die; however, without a detailed water quality investigation, it will be difficult to prove that leachate was the cause. Water level

management and construction impacts can be equally important in the death of the vegetation.

13. Florida Power Corporation has no plans to utilize ground water from the Crystal River power generating site itself. Therefore, possible deterioration of groundwater quality would not involve any constraint as long as the site is occupied by Florida Power Corporation. No major existing water users are within close proximity to the plant site.
14. The leachate will move outward and downward from the storage areas. It is believed that most leachate will move outward at shallow depths (i.e., less than 50 feet below existing grade). Movement will concentrate along the surface of the less permeable materials.
15. The leachate may show up as surface water via stormwater runoff system, via seepage out of the unconsolidated soil material, and/or through solution channels in the limerock downgradient from the storage areas.

5.4

PSD ANALYSIS--AIR QUALITY

5.4.1 CLASS II PSD ANALYSIS

LONG-TERM ANALYSIS

Annual average impacts for both baseline and 1984 conditions were determined utilizing a five-year (1971-75) hourly meteorological record from Tampa International Airport. Because of the five-year record, these data were preferred over the one-year, on-site data mentioned in Chapter 2.8 (Climatology and Dispersion Meteorology).

Prevention of Significant Deterioration (PSD) analysis was made in the vicinity of the Crystal River site, designated Class II, and at the Chassahowitzka National Wilderness Area, nearly 21 kilometers (13 miles) south of the proposed plant site and designated as a Class I area. In the figures and tables to follow, both the SO₂ and TSP maximum impacts and PSD increments are determined and compared with the allowable PSD increment and most restrictive Ambient Air Quality Standards (AAQS).

Annual average SO₂ and TSP baseline concentrations are shown in Figures 5.4-1 and 5.4-2, respectively. The SO₂ maximum of 5 ug/m³ lies approximately 6 kilometers (4 miles) east of the existing Crystal River units. The ground-level TSP concentrations in Figure 5.4-2 are negligible except for an excluded ambient background concentration.

Figures 5.4-3 and 5.4-4 portray the annual average SO₂ and TSP concentrations with operation of the proposed units. Both figures represent a small change in the annual SO₂ and TSP air quality at the site. The SO₂ and TSP incremental impacts for the proposed units only are shown in Figures 5.4-5 and 5.4-6, respectively.

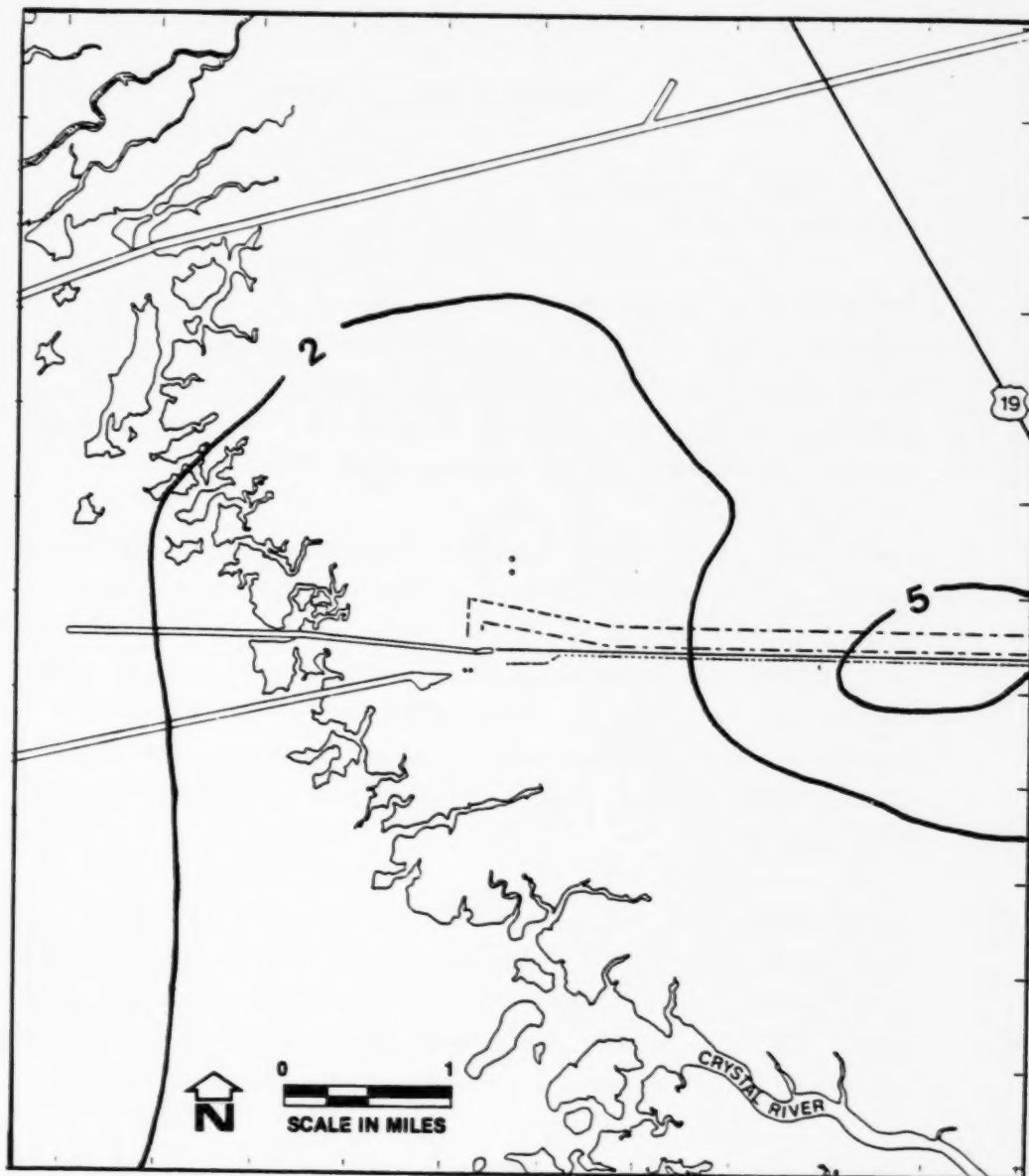


Figure 5.4-1
ESTIMATED ANNUAL AVERAGE SULFUR DIOXIDE
BASELINE CONCENTRATIONS ($\mu\text{g}/\text{m}^3$) IN THE VICINITY
OF FLORIDA POWER CORPORATION CRYSTAL RIVER,
1974

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

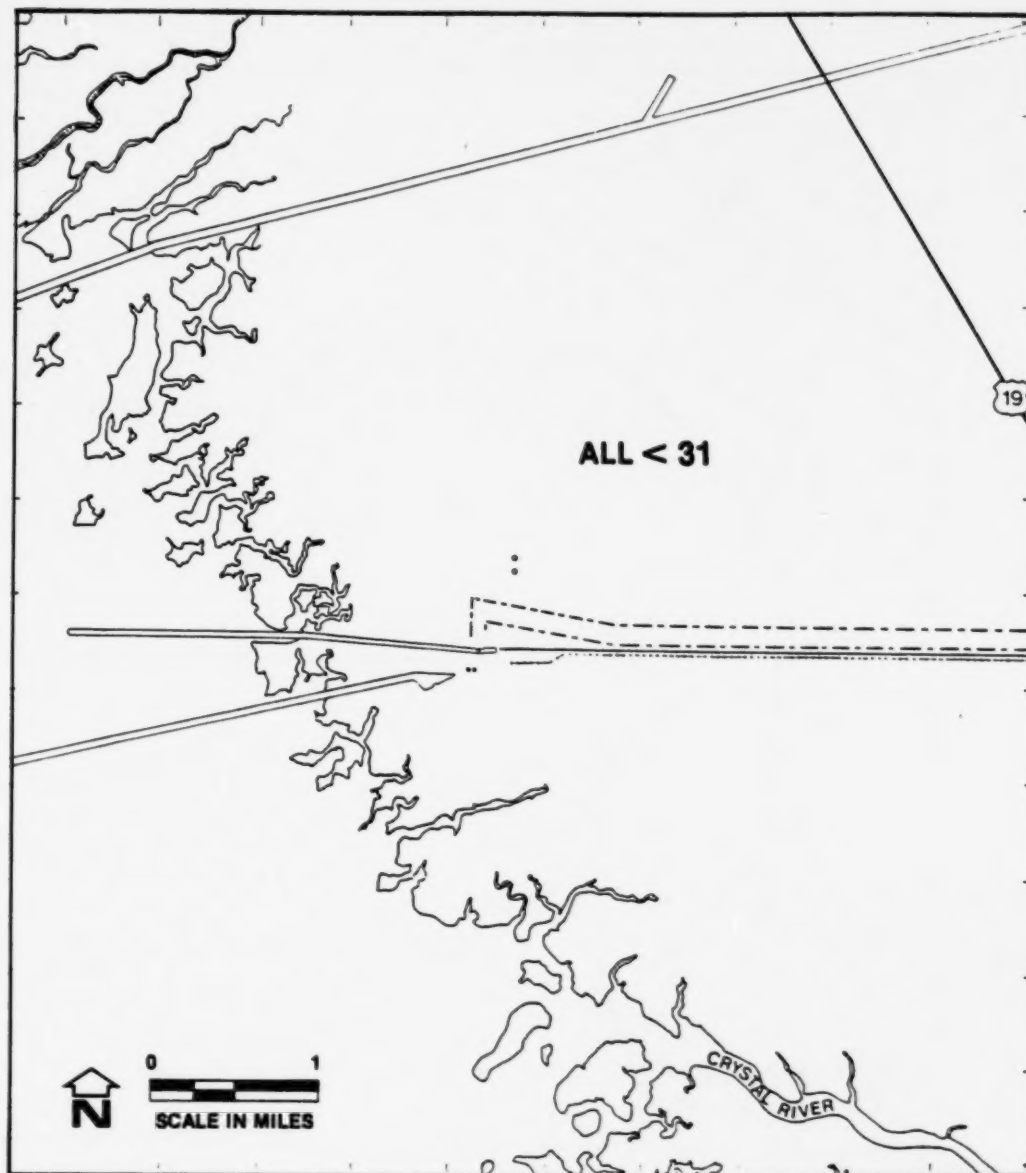


Figure 5.4-2
ESTIMATED ANNUAL AVERAGE TOTAL SUSPENDED
PARTICULATE BASELINE CONCENTRATIONS ($\mu\text{g}/\text{m}^3$) IN
THE VICINITY OF FLORIDA POWER CORPORATION
CRYSTAL RIVER, 1974

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

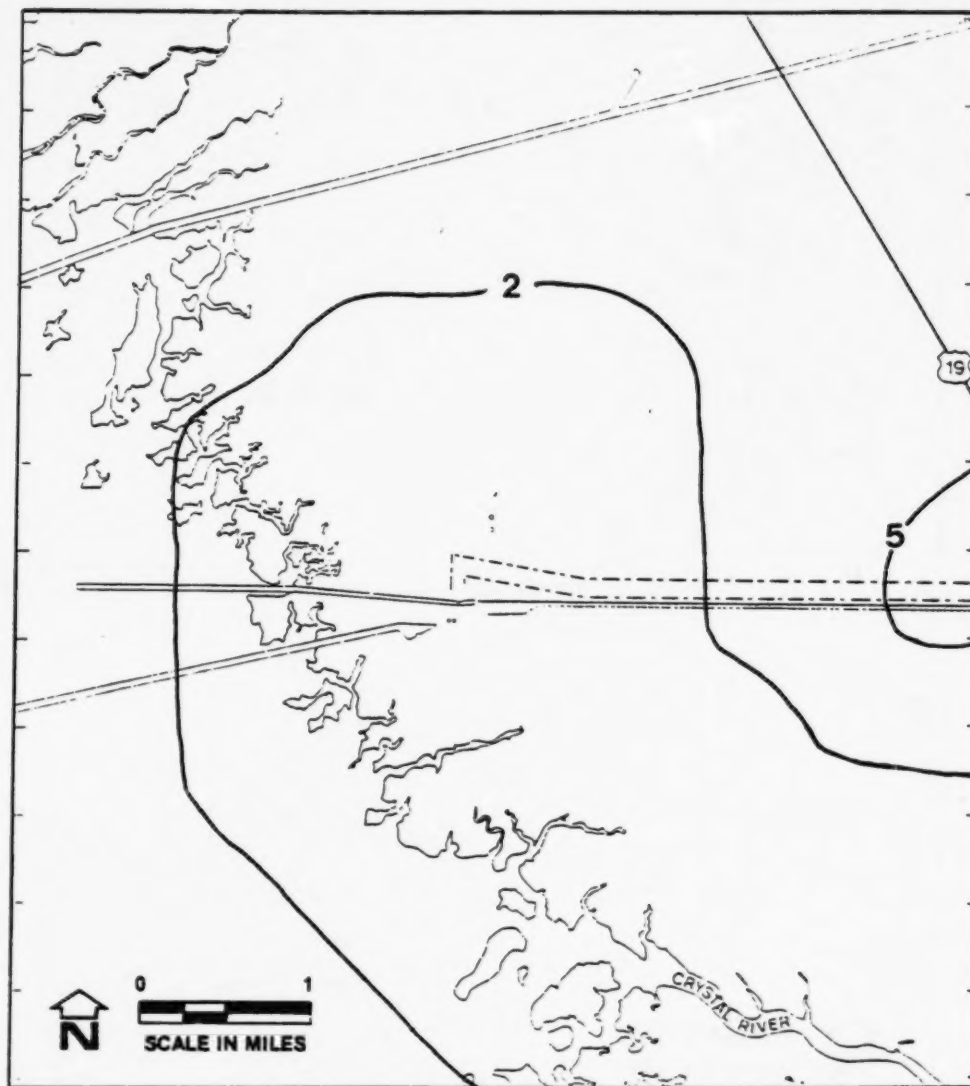


Figure 5.4-3
ESTIMATED ANNUAL AVERAGE GROUNDLEVEL SULFUR
DIOXIDE CONCENTRATION ($\mu\text{g}/\text{m}^3$), FOR ALL SOURCES
WITH PROPOSED UNITS, 1984

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

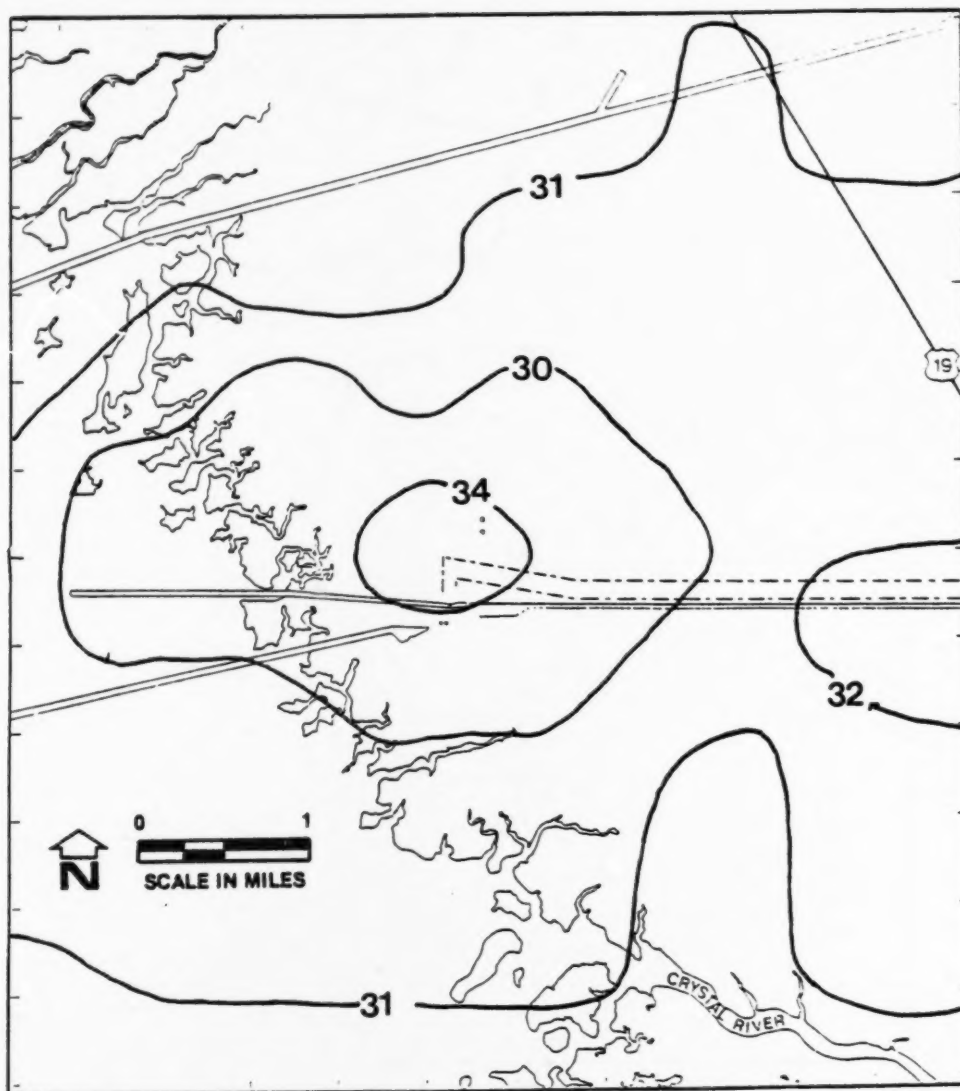


Figure 5.4-4
ESTIMATED ANNUAL AVERAGE GROUNDLEVEL
PARTICULATE MATTER CONCENTRATIONS ($\mu\text{g}/\text{m}^3$),
FOR ALL SOURCES WITH PROPOSED UNITS AND
FUGITIVE DUST SOURCES, 1984

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

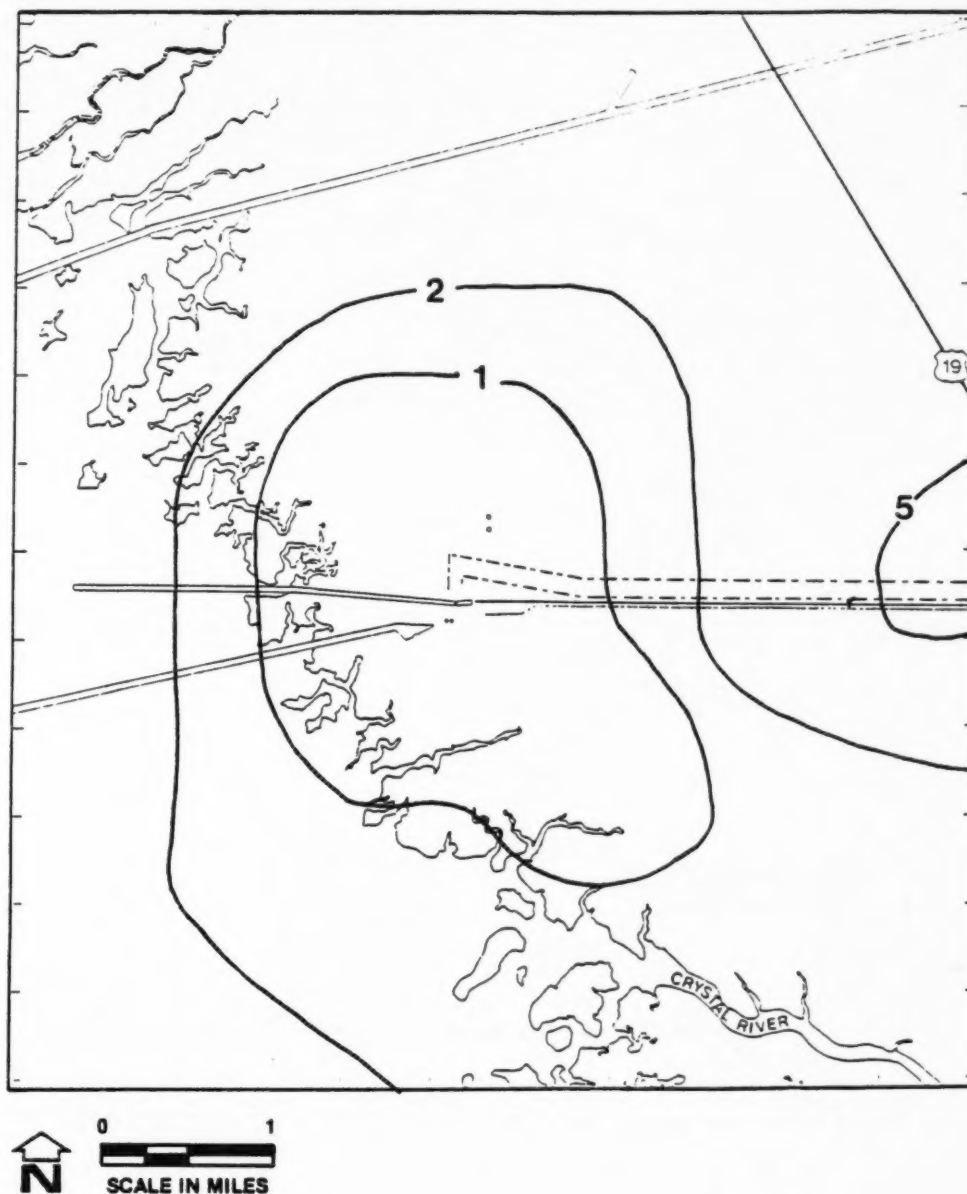


Figure 5.4-5
ESTIMATED ANNUAL AVERAGE GROUNDLEVEL SULFUR
DIOXIDE CONCENTRATIONS ($\mu\text{g}/\text{m}^3$), FLORIDA POWER
CORPORATION, INCREMENTAL IMPACT OF FLORIDA
POWER CORPORATION

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978

FLORIDA POWER CORPORATION

PROPOSED
 CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

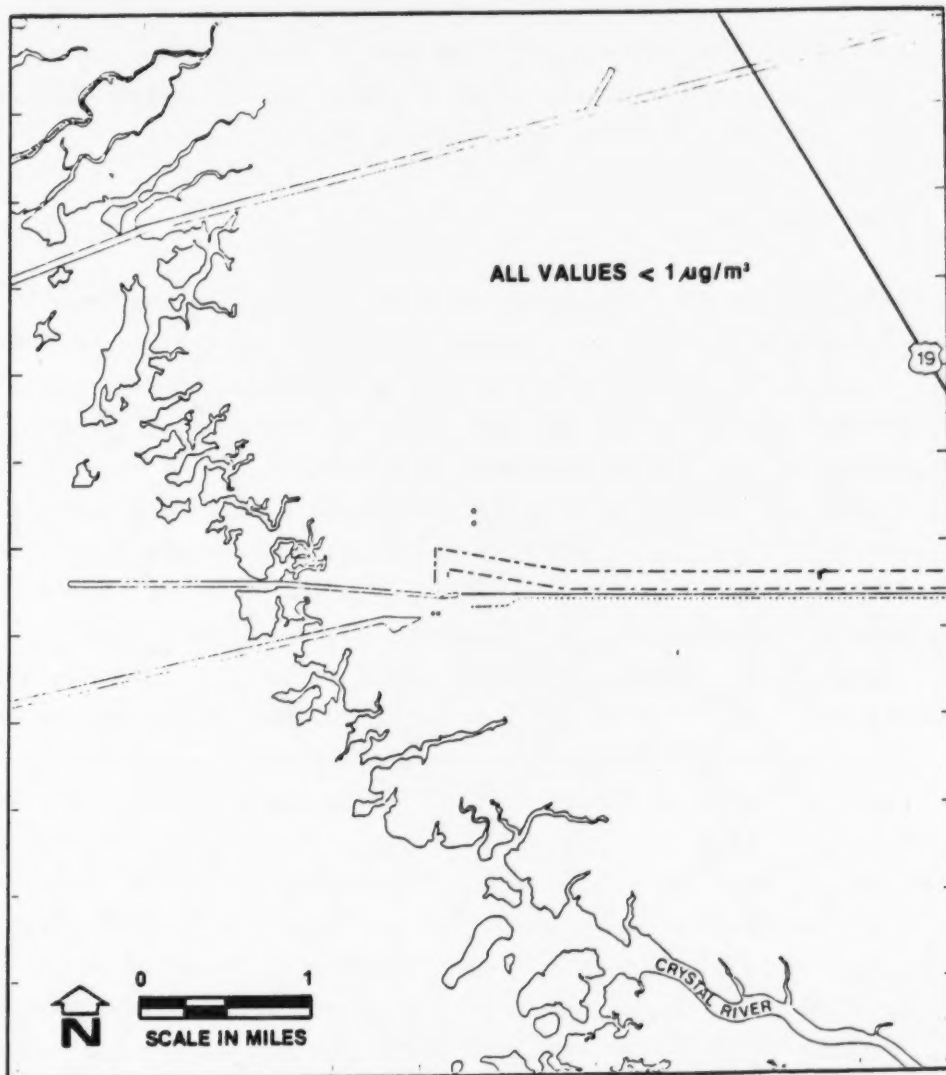


Figure 5.4-8
ESTIMATED ANNUAL AVERAGE GROUNDLEVEL
PARTICULATE MATTER CONCENTRATIONS ($\mu\text{g}/\text{m}^3$),
FLORIDA POWER CORPORATION, INCREMENTAL
IMPACT OF FLORIDA POWER CORPORATION

SOURCE: ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., 1978 1978

FLORIDA POWER CORPORATION

PROPOSED
CRYSTAL RIVER UNITS 4 & 5

CITRUS COUNTY, FLORIDA

Table 5.4-1 summarizes the maximum annual and short-term SO₂ and TSP concentrations and PSD increments for all Class II areas. The table will be discussed in the following section.

SHORT-TERM ANALYSIS

Maximum short-term concentrations were determined by utilizing a five-year CRSTER model to calculate the worst days and periods for each scenario. Once these days were determined, further resolution of maximum impacts and PSD increments was determined using the PTMTP-W model. As per current EPA modeling guidelines, the highest and second-highest concentrations were used to determine compliance with all AAQS and PSD increments. Table 5.4-1 shows that the maximum 24-hour SO₂ concentration from Units 4 and 5 is 45 ug/m³, while the three-hour maximum is 583 ug/m³. The 1984 values represent the maximum concentrations after the proposed units are on line. Existing Units 1 and 2 are run at the strategy of 2.0 pounds SO₂ per million Btu and 0.1 pound TSP per million Btu heat input. Units 4 and 5 are run at their maximum allowable rate of 1.2 pounds SO₂ per million Btu and 0.1 pound TSP per million Btu heat input. The maximum increase over the baseline concentration is taken at the receptor where this increment is a maximum, regardless of whether or not it was the maximum concentration. The maximum three-hour SO₂ increment of 198 ug/m³ is the critical Class II increment and is 40 percent below of the allowable 512 ug/m³. All other increments and concentrations are well below allowable limits.

PARTICULATE DEPOSITION

In order to determine the effect on the amount and the location of particulate matter deposition due to Units 4 and 5, a modified version of the methodology described by Bosanquet, et al., (1950) was used. Since the main concern for this determination is the larger particles, no credit for plume buoyancy was given in the computation of the plume rise. It was assumed that the larger particles would begin to fall out

Table 5.4-1 Summary of Significant Deterioration Analysis, Class II Areas, Florida Power Corporation, Crystal River Units 4 and 5, Citrus County, Florida

Scenario	Maximum Concentration (ug/m ³)				
	Sulfur Dioxide			Total Suspended Particulate*	
	Average	24-Hour	3-Hour	Average	24-Hour
Incremental Impact Crystal River Units 4 and 5	3	45	291	<1	4
Maximum in Area 1974 Baseline	5	65	583	30	56
1984 with Units 4 and 5	6	69	395	36	58
Maximum Increase Over Baseline at Worst Receptor	1	12	198	6	2
State of Florida AAQS's Allowable Federal Increment	60 20	260 91	1,300 512	60 19	150 37

* Concentrations include a background level of 30 ug/m³.
Source: Environmental Science and Engineering, Inc., 1977.

of the plume after their initial momentum because the stack velocity had been dampened by the atmosphere. This assumption constituted the only deviation from Bosanquet's procedure. Once the effective plume height had been determined, the deposition rate was computed from a weighted average of the particle size distribution, the fall velocity of the particles as determined from their sizes and densities, and the wind speed at stack height. Since the wind speed is the most critical factor in the location of the dustfall, different speeds were considered. The local deposition under the conditions of strong winds is relative in significance. As might be expected, the highest dustfall rate occurs under the conditions of low wind speed. The maximum deposition rate which is estimated to occur 7 kilometers (4 miles) from the site, is less than $0.5 \text{ mg/m}^2/\text{day}$. At 14 kilometers (8.7 miles), the maximum deposition rate is estimated at less than $0.2 \text{ mg/m}^2/\text{day}$. Such deposition, however, would only occur downwind from Units 4 and 5. The impacts from the estimated deposition rates would not be detectable.

5.4.2 CLASS I PDS ANALYSIS

The Clean Air Act Amendments of 1977 require that all national wilderness areas which exceed 2,050 hectares (5,000 acres) in size be designated as Class I areas for PSD purposes. Therefore, Chassahowitzka National Wilderness Area is required to be a Class I area. The allowable PSD increments for Class I areas are:

Particulate Matter:

Annual geometric mean	5 ug/m ³
24-hour maximum	10 ug/m ³

Sulfur Dioxide:

Annual arithmetic mean	2 ug/m ³
24-hour maximum	5 ug/m ³
3-hour maximum	25 ug/m ³

The distance from the proposed source to the Chassahowitzka National Wilderness Area boundary is approximately 21 kilometers (13 miles).

Presented in Table 5.4.2 is the maximum predicted baseline, incremental, and 1984 estimated sulfur dioxide and TSP concentrations. The three-hour maximum increment attained was 25 ug/m³ which is exactly equal to the allowable limit. This critical increment determined the fuel strategy to be used in the entire modeling effort for Units 1 and 2. The other SO₂ and TSP increments are well below the allowable Class I increments.

Table 5.4-2 Summary of Significant Deterioration Analysis, Class I Area--Chassahowitzka National Wilderness Area, Florida Power Corporation's Units 4 and 5, Citrus County, Florida

Scenario	Maximum Concentration (ug/m ³)				
	Sulfur Dioxide		Total Suspended Particulate*		
	Annual Average	24-Hour	3-Hour	Annual Average	24-Hour
Crystal River Units 4 and 5 Incremental Impact	<<1	10	52	<<1	1
Maximum in Class I Area					
1974 Baseline	1	30	99	30	32
1984 with Units 4 and 5	1	20	116	30	32
Increase Since Baseline	<<1	<1	25	<<1	1
Allowable Federal Increment	2	5	25	5	10

* Background TSP concentration of 30 ug/m³ added to modeling results.
Source: Environmental Science and Engineering, Inc., 1977.

5.4.3 CONCLUSIONS

Utilizing an SO₂ final strategy in the existing Crystal River Units 1 and 2 of 2.0 pounds per million Btu heat input, and 1.2 pounds SO₂ per million Btu heat input in the proposed units, all the annual average and short-term SO₂ and TSP AAQS and PSD increments will be met. The three-hour Class I increment of 25 ug/m³ was utilized as the limiting SO₂ fuel strategy on the existing units.

The Division of Recreation and Parks, Department of Natural Resources administers the Crystal River Archaeological Site (a pre-Columbian site), which is located approximately 8 kilometers (40 miles) southeast of the proposed units. The frequency of direct impact to the air quality at this site will be less than 4 percent of the time. Annual average concentrations of TSP and SO₂ contributed by Units 4 and 5 will be less than 2 percent of the applicable AAQS's which were promulgated, in part, to prevent air pollution damage to materials. The stack, although 183 meters (600 feet) in height, will not be visible due to ground cover in the vicinity of the archaeological site.

The resulting air quality using the control strategy indicated previously in Section 5.4.3 on Units 1, 2, 4, and 5 in the Crystal River area will be higher than with Units 1 and 2 alone.

5.5

DIRECTLY ASSOCIATED TRANSMISSION SYSTEM

The existing transmission lines serving Units 1, 2, and 3 at the site are adequate to transmit the power generated by proposed Units 4 and 5. The only transmission lines necessary for the proposed units are the interconnections to existing site substations. As depicted in Chapter 3, the route of these interconnecting lines will extend slightly to the west of the proposed units.

Since the interconnecting lines will cross only areas that are to be filled and graded for site development, no additional impacts to terrestrial or aquatic communities are expected as a result of transmission system construction. Florida Power Corporation will allow vegetation to grow under the lines as long as this practice is safe and does not reduce accessibility. When the height of vegetation becomes excessive, mechanical trimming will be utilized. Florida Power does not intend to use herbicides for vegetative control under these lines or elsewhere on the plant site.

Studies by Scherer, et al. (1973), and Frydman, et al. (1973), have shown that the maximum concentrations of ozone (less than 0.02 ppm) produced by transmission lines of up to 765 kv are insufficient to cause impacts to neighboring vegetation, since threshold injury levels lower than 0.05 ppm (98 ug/m³) for 4 hours have not been demonstrated (ASA, Inc., 1976).

5.6

DIRECTLY ASSOCIATED FACILITIES

Aspects of plant operation considered in this section include: coal handling; bottom and fly ash handling; solid waste disposal and land reclamation; noise generation; and barge, train, and highway traffic.

5.6.1 COAL HANDLING

Conveyance, storage, and crushing of coal are potential sources of particulate matter emissions to the atmosphere. Meteorological conditions such as wind speed and humidity are the primary factors which influence particulate emissions from coal storage. The transfer and processing of coal for combustion are potentially significant sources of particulate matter, but will be subject to controls in the proposed facility design. The controls will include wetting agents for open areas and bag filters for enclosed operations (conveyors, transfer points, silos, and crushers). The bag filters will control particulate emissions to 99.9 percent (U.S. EPA, 1972) and the wetting agents will reduce dust emissions by as much as 90 percent (Amick, et al., 1974). In addition, the particulate matter generated by plant operations will ordinarily consist of sufficiently large particles to settle out on-site. In general, the occurrence of particulate matter emissions due to coal handling is not expected to degrade air quality near the plant site (see Section 5.4).

5.6.2 BOTTOM AND FLY ASH HANDLING

The proposed equipment and procedures for handling solid wastes will minimize the possibility of particulate matter emissions to the atmosphere. The economizer ash, bottom ash, coal pulverizer rejects and water pretreatment sludge will all be sluiced or pumped to handling areas rather than conveyed in dry form. Fly ash will be pneumatically conveyed in an enclosed system to the storage silo. After dewatering, solid wastes will be transported by truck or conveyor to an on-site storage area. Wetting agents will be utilized to minimize particulate matter emissions during this process. As a result of these controls, the solid waste management activities are not expected to yield major emissions of particulate materials.

5.6.3 SOLID WASTE DISPOSAL AND LAND RECLAMATION

The dewatered bottom ash, pulverizer rejects, economizer ash, pretreatment system sludge, and precipitator fly ash produced during the operating life of Crystal River Units 4 and 5 will be stored on-site in an area of approximately 48 hectares (120 acres). The storage area will be developed in 8-hectare (20-acre) segments, with each segment filled to a height of 12.2 meters (40 feet) above the existing grade. Assuming a storage area margin of 3,000 meters (9,842 feet) and side slopes of 3:1, the area will have a maximum capacity of roughly 5.25 million cubic meters. This would be sufficient for storage of 27.2 years' output of solid waste, at an average daily production of 528 cubic meters (see Table 3.6-1). In actuality, not all of the ash storage capacity may be utilized during the active life of Units 4 and 5, if Florida Power is able to find buyers for the fly ash output.

The storage pile slopes will be dressed with soil material of sufficient depth to support vegetation. As each segment is developed to design height, the top surface will be sloped to drain and dressed with soil materials. Thus, the project ultimately will involve the creation of an elevated grassy area rising roughly 12 meters (40 feet) above the surrounding landscape and measuring approximately 0.8 kilometer (0.5 mile) in maximum dimension. This artificial landform should not comprise a significant aesthetic impact so long as the tree cover is maintained on land to the east. However, the ash storage function will foreclose many potential future uses of the land and must be considered a negative impact in terms of long-term commitment of resources.

Solid wastes generated by the operation of Units 4 and 5 will include office wastes, trash, garbage, and scrap lumber and metal. Scrap lumber and metal will be recycled. Other wastes will be landfilled in approved areas near the new units, or disposed of by an outside contractor.

5.6.4 NOISE

The major noise sources associated with the proposed facilities are the cooling towers, coal transfer and crushing operations, turbine and boiler functions, and other miscellaneous sources (vehicular traffic, ash handling, etc.). Some of these types of sources are already present at the existing power generation facilities. The noise effects of the new facilities will represent increments relative to existing noise sources, a fact which will moderate their impact on potential receptors.

In determining the worst-case noise impacts of the proposed project, a sound pressure level of 90 dBA has been estimated to occur at a distance of 15.2 meters (50 feet) from the center of sound pressure at the project site. Assuming that there is a 6 dBA reduction for each doubling of distance (see Section 4.2.2), the worst-case impact at 6 kilometers would be 46 dBA. Using the simplified sound-level reduction curve developed in Section 2.10 (Figure 2.10.1-4), a reduction to 45 dBA is estimated. These sound pressure levels are consistent with those found by Teplitzky (1977) for cooling towers. These levels are comparable to urban predawn background noise.

Presently there are fewer than 10 occupied dwellings within 6 kilometers (3.7 miles) of the proposed plant site, and relatively little development within this radius is expected in the future. The sound pressure level of 45 to 46 dBA which is predicted to occur at 6 kilometers from the proposed plant site would be comparable to urban predawn background noise. For much of the area closest to the site which might be developed in the future, the noise levels attributable to the proposed plant would be eclipsed by traffic noise on U.S. Route 19-98. Finally, noise levels exceeding 45 dBA are frequently produced by natural agents such as insects, without any influence of human activity. Thus, the noise effects of the proposed project are not considered a significant impact, due to the lack of receptors near the plant site.

5.6.5 TRANSPORTATION

Both road and rail traffic will produce some road-kills of wildlife, but it is unlikely that this would have a detectable effect on wildlife populations.

Barge traffic in the intake canal could impact the Florida manatee, which occurs in the area. Populations of this species are thought to move between the Withlacoochee and Crystal Rivers. Less than 25 sightings of manatees in or near the power plant canals have been recorded by the U.S. Fish and Wildlife Service in the past three years (Irvin, 1977, personal communication). Sightings were reported by aerial surveys and from researchers working on studies near the existing plants.

Manatees appear to prefer the Crystal River area to the discharge canals. Insofar as they frequent the canals, the heated effluent of the discharge canal would appear to provide a greater attraction than the intake canal. Barge movements would provide a hazard to manatees only in the intake canal and in the adjacent coastal waters. However, it is likely that the increased traffic due to power generating Units 4 and 5 will result in a somewhat greater incidence of manatee injury or mortality than present conditions.

IMPACTS

As discussed previously, no manatee bodies have yet been collected by Fish and Wildlife in the area of the plant despite the barge traffic associated with Units 1 and 2. Most carcasses collected in the study apparently died as a result of motor boats which take a heavy toll each year on the manatee populations.

Thermal impacts to the manatee appear to be unchanged by the addition of discharges from Units 4 and 5. Since the proposed plants are to be

FPCR4/5-TSD5.1/R5-6.8
3/25/80

cooled by means of natural draft saltwater towers, no significant thermal discharges are anticipated. It appears that the addition of Units 4 and 5 at the site would make the existing discharge no more or less attractive to the manatees than at present.

5.7 RESOURCES COMMITTED AND UNAVOIDABLE ENVIRONMENTAL IMPACTS

The most important commitments of natural resources involved in the operation of the proposed facility are: (1) fuel consumption, (2) water consumption, (3) leaching of pollutants into subsurface waters, and (4) utilization of air quality increments.

Fuels consumed by the plant will include coal from deposits in the western and eastern United States as well as other fossil fuels (see , Chapter 3). Most of the fossil fuel used will be burned to produce power. Other fossil fuel derivatives will be used for start-up, lubricants, solvents, and paints. Yearly average amounts of coal burned by Units 4 and 5 during their 30-year projected life will be approximately 3.4 million metric tons (3.74 million tons). Coal, including lignite, consumed by power generation in the United States in 1975 equalled 368 million metric tons (U.S. Department of Commerce, 1976). Thus, projected coal consumption per year for Units 4 and 5 would amount to about 1 percent of all coal usage for electric generation in 1975. This percent will decline rapidly in the future, however, with the nationwide rise in coal usage for power generation.

Maximum fuel-oil usage for furnace warm-up and coal ignition during start up will be 10.6 million liters (2.8 million gallons) per year for each unit, based on an average of 200 starts per year. The facility will also consume fossil fuels indirectly. Fuels will be burned elsewhere to provide energy for manufacturing spare parts and transporting materials and people as required by the project. On a tertiary level, the facility will contribute to other fuel usage by providing power to high growth areas in the state. The availability of power at reasonable rates will facilitate economic development, whereas power shortages constrain future growth.

The proposed facilities will consume fresh ground water. Units 4 and 5 will require a peak of 2,133 liters per minute (401 gallons per minute). Impacts associated with the groundwater withdrawals are discussed in Chapter 5. These impacts were calculated from June 1978 pump test data

6/27/80

(Geraghty and Miller, 1978) collected at the west end of the proposed well field. The projected maximum well field capacity is less than 1 percent of the flow at Crystal River and about 1 percent of the estimated flow to the Gulf between the Withlacoochee and Crystal Rivers. The annual average water usage will be less than one-fifth of the well field capacity. The above mentioned quantities of fresh ground water will not be available for other uses during the operating life of the plant. This commitment is not irreversible.

Projected average groundwater use by the facility is 45 million lpd (12 million gpd). The total freshwater demands in Citrus County in 1985 are estimated to be 100 million lpd (26.5 million gpd), excluding power plant requirements (Geraghty and Miller, 1977). Estimated groundwater budgets indicate that about 6 percent of available ground water would be used by the proposed generating units 4 and 5. An estimated 1,325 million lpd (355 million gpd) will be available in the chosen computational area (see Section 5.1.1). Water committed to plant needs will not be available for other uses during the operating life of the plant. This commitment is not irreversible, but amounts to a 30- to 40-year agreement.

The proposed power generating units will consume increments of surface water pollution, which will be unavailable to other users, as follows:

1. Cooling system blowdown produced at the site;
2. Wastewater effluents at coal mining sites; and
3. Domestic wastewater in Citrus County from worker dwellings.
4. Contaminated stormwater runoff.

Blowdown projections are given in Chapter 3. Because of the dilution factor provided by the cooling water for Units 1, 2, and 3, the impacts of blowdown discharges are unlikely to be significant. No estimates are available for secondary additions resulting from the facility.

Soils on the site will be exposed to leachates from exfiltration of storage and disposal areas. The leachates may contain many materials such as arsenic, copper, lead, vanadium, cadmium, cobalt, and chromium. Changes in the concentrations of these materials in the soil will take

place. Presumably, elevated concentrations will linger for a long period of time. The resource commitment implied by this impact is discussed in Section 5.3.

Air quality increments allowed in various areas are presently defined by federal law (P.L. 95-95). Operation of the proposed facility will consume some parts of their increments, which will then be unavailable for other purposes. The annual emissions for Units 4 and 5 are estimated to be 1.2 pounds sulfur dioxide and 0.1 pounds of total suspended particulates per million Btu heat input at 74 percent load. The following percentages of Class II air quality increments will be consumed at the point of maximum increment:

<u>Pollutant</u>	<u>Average Percentage Class II Air Quality Increments</u>		
	<u>Annual Average</u>	<u>24-Hour</u>	<u>3-Hour</u>
Total Suspended Particulates	32*	5	N/A
Sulfur Dioxide	5	13	39

*Includes fugitive dust emissions at proposed site, not included in 24-hour increment.

The proposed project will also consume Class I PSD air quality increments at the (Chassahowitzka Wilderness Area). Worst case estimates indicate that a portion of the TSP Class I increment and 100 percent of the 3-hour sulfur dioxide Class I increment will be consumed. This air quality deterioration will occur primarily when winds originate from the north. The frequency of occurrence of these wind directions is approximately 7 percent or 26 days per year. These effects will end when the plant serves its useful life.

5.8

MITIGATIVE MEASURES

Mitigative measures to reduce environmental impact can be demonstrated by Florida Power Corporation's site selection, site plan layout, and control technology. These are discussed in the following sections (also see NPDES Part III requirements).

5.8.1 SITE SELECTION

The selection of the Crystal River site presents several environmental advantages. These include:

1. Potential impacts and commitments of resources attributable to the construction of new transmission lines will be avoided by utilizing the existing transmission corridor at the selected site. Typical corridors require about 5 hectares (12 acres) of land per mile of transmission line.
2. Existing navigable canals at the selected site will accommodate future coal deliveries, thereby minimizing potential dredging impacts, particularly on aquatic and terrestrial ecosystems.
3. Existing discharge flows from Units 1, 2, and 3 will serve to dilute cooling water blowdown and any contaminated stormwater runoff discharge from Units 4 and 5 (Chapter 5) after settling.
4. The proximity of the proposed units to other facilities operated by Florida Power presents an advantageous flexibility in air pollution control strategies. This situation is even more important since Florida Power will control the majority of emission sources in the vicinity.

5.8.2 ARRANGEMENT ON THE SITE

Florida Power has chosen to arrange the new facilities on the site in such a way as to minimize environmental impacts. Proposed facilities have been designed to avoid displacing wetlands and valuable habitats such as the salt marsh and coastal hydric hammocks. As indicated in Chapter 9, other layouts of the facility were feasible, but Florida Power selected a plan which would minimize impacts to more sensitive ecological systems. Also, in the proposed arrangement the facilities are farther removed from areas of archeological site concentration than in other site plans which were considered.

5.8.3 CONTROL TECHNOLOGY

Plant design incorporates a number of mitigative features. Florida Power's plans to use closed-cycle cooling represent a large reduction in thermal additions to the nearby estuary. In addition, the use of natural draft cooling towers will produce less noise, less drift, and consume less fuel than mechanical draft towers.

The proposed source of cooling water for the facility is brackish water from the existing discharge canal serving Crystal River Units 1, 2, and 3. Since the water at the point of intake has been discharged by the other units, this plan actually represents the reuse of wastewater and eliminates the commitment of additional natural waters for cooling purposes on the site.

Several aspects of using this water source will minimize the potential biological impacts due to impingement and entrainment. First, the intake water velocity of 0.04-0.15 meter per second (0.12-0.5 foot per second) complies with current EPA intake velocity design criteria. Also, the intake flow rate for normal operation represents only approximately five percent of the total flow rate in the discharge canal. Barrier nets, floating brooms, and/or trash racks will be located immediately in front of each intake traveling screen to deflect various debris, including the larger organisms. Probably the most important aspects of this plan for minimizing biological impacts are that the water has previously been used in the cooling systems of Units 1, 2, and 3 and that the discharge canal at the intake structure location and above is a relative barren biological or feeding area. Most organisms in the intake area have already been killed by the thermal and mechanical impacts of Units 1, 2, and 3, or would generally be larger, faster-swimming species of fishes which could avoid impingement. As a consequence, the quantity of living fishes and other organisms available for impingement or entrainment is much less than would normally be available for such a surface water intake system or as currently occurs for

Units 1, 2, and 3 intakes. Thermal output of Units 1, 2, and 3 is reduced a minor amount during the summer due to the use of discharge water.

Burning low-sulfur coals will result in less degradation of air quality than burning high-sulfur coals. Scrubbers are not necessary when using low-sulfur coals, and therefore are not planned for Units 4 and 5. Without the use of scrubbers, stack emissions are hotter and the potential dispersion of air pollutants is greater. Also the potential volume of solid wastes from the facility will be reduced by eliminating scrubber sludge.

The use of scrubbers results in a reduction of the electrical generation which can take place for a given amount of fuel. If other control technology is used, this lost fuel would be made available for other uses. Consequently, the improved fuel efficiency of the newer units allows more electricity to be produced with fewer air emissions for a given amount of fuel.